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By Will H. Coghill

Mineralized Volcanic Explosion Vents

By R. T. Walker

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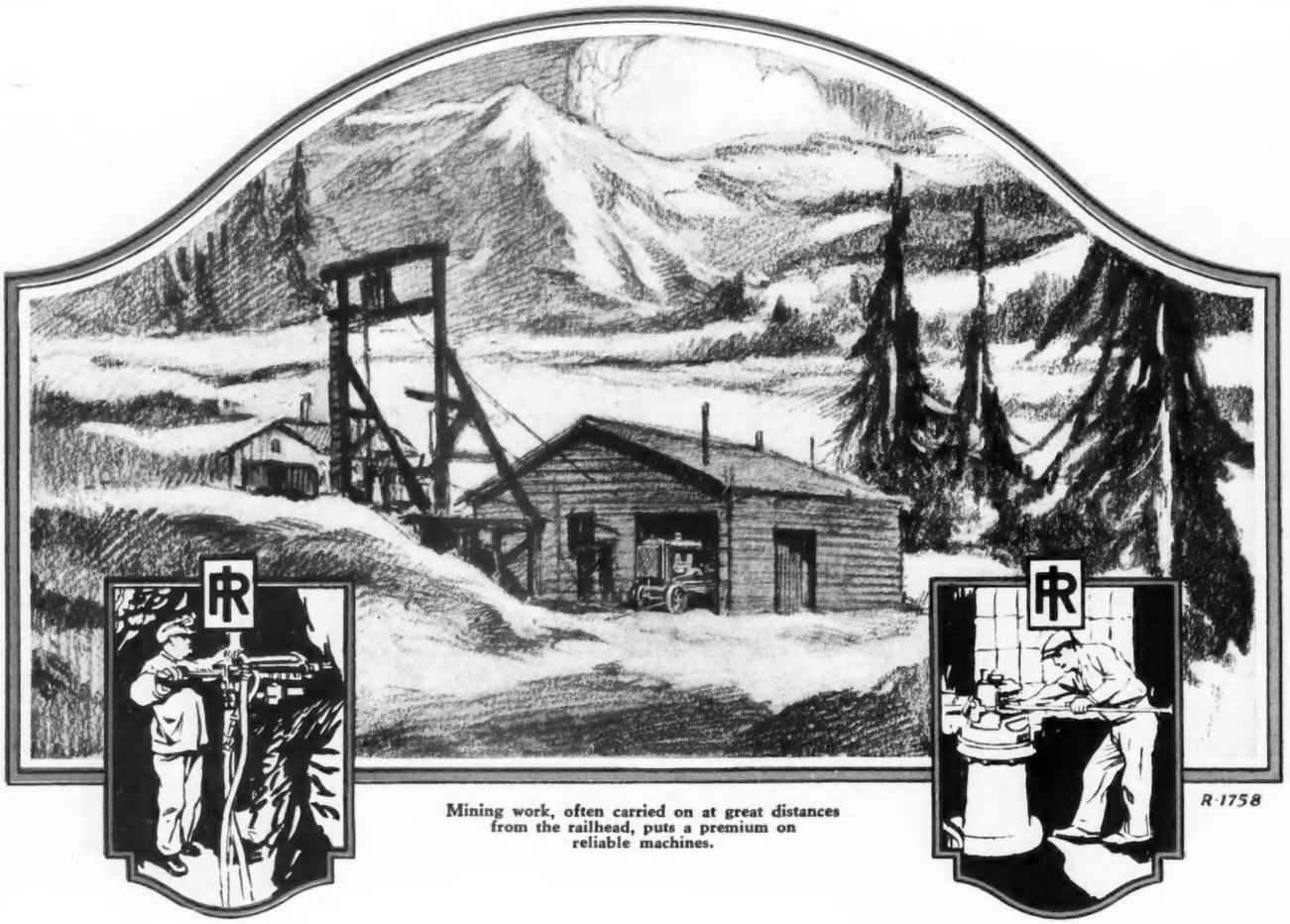
The American Mining Congress Meets at Washington

Cost-Cutting Innovations—A New Department of Practical Ideas Beginning in This Issue



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EVERY WEEK your friends the editors try to reflect, in the columns of *E. & M. J.*, your purposes and to promote your interests. They can do this best if you will comment freely on what you read in its pages, either for publication or in a private letter. The editors are trying to do a good job. They will welcome suggestions as to how they can do an even better one.

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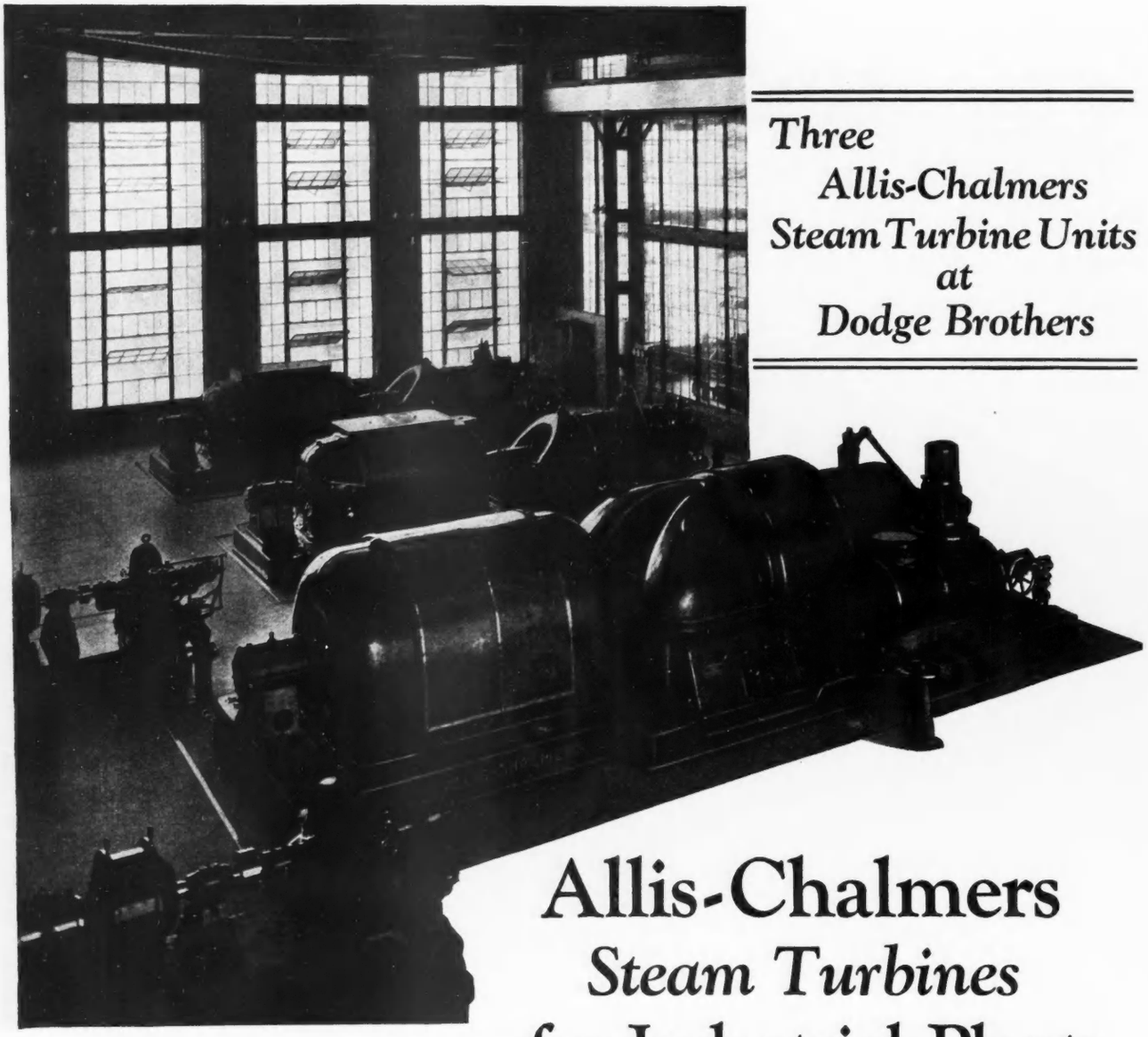

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A. W. ALLEN,
Editor

VOLUME 126 — *New York, December 15, 1928* — NUMBER 24

Economy Versus Pruning of Government Appropriations

WHEN Government becomes economical it is news, for Government is usually wasteful. Such economy attracts attention and, if it be continued, admiration. This is only natural. Upon analysis, however, the economy may prove faulty or even bogus, especially when found to have been achieved, in whole or part, by curtailment of outlay for useful purposes, while wasteful spending elsewhere is permitted to continue.

A proposed budget may be reduced in two ways: first, by a horizontal cut, affecting all the items. This is the easier of the two and, possibly for this reason, is the one in vogue in Washington. The other way is selective and involves the careful, expert scrutiny of each item prior to deciding whether it shall be cut, or be left unchanged, or even increased. Obviously, this is the longer and more difficult method. Obviously, also, it has not been in vogue in Washington, for otherwise some useless bureaus and bodies would have passed out of existence long since for lack of funds.

How does the Bureau of the Budget manage to continue on its ruthless course of cutting needed appropriations? Do not the bureau heads concerned protest? Even if they do not, the industries affected by the resultant curtailment or stoppage of research conducted for them might be expected to object. Ordinarily they do not get the chance, however, for even though a hearing be held, the announcement respecting it is not made sufficiently in advance to enable those interested to send their representatives. In this respect the budget machine functions as a steam roller as well as a guillotine.

As a result of the arbitrary cutting by the Bureau of the Budget of appropriations asked for, the Bureau of Mines will receive about $336,000 less for research and investigational work in the coming fiscal year than it has for the current year, unless Congress overrides the budget. This is doubly unfortunate, inasmuch as, by virtue of the Welsh Act, it would appear that the Bureau will have to pay in excess of $110,000 more in increased salaries in the coming year, which must be taken from the reduced appropriation. Thus it will really have nearly half a million dollars less for its research work than it has this year. The budget as submitted to Congress by the President allows a total of $2,249,670 for the Bureau.

In contrast are the sums allotted to the Department of Agriculture to permit it to carry out its program. The total is no less than $73,000,000, if road building be excluded. For federal aid to the state Agricultural Experiment Stations alone the budget includes an item of $2,880,000, which is larger than the total appropriation for the Bureau of Mines, and, to boot, is $480,000 more than the Agricultural Stations have for the current year.

The reasons for this situation are not hard to find. Agriculture controls more votes, but it is also true that the mining industry is not sufficiently articulate; it fails to speak for itself so that it can be heard. When economy is on the program, appropriations are cut where objections are likely to be least. An industry that keeps silent will go ignored in Washington. If it really desires what it needs, it must say so—loudly and often. The metal-mining industry has few champions in Congress and therefore should make a greater effort to be heard.

The cut made in the Bureau's appropriations cannot be justified on the ground that there is less to do. The demand upon the Bureau to undertake new metallurgical research is great. Much of the work that it has done for the metal-mining industry has been along this line. Operators would now like to see it undertake studies that have for their object the lowering of mining costs and the determination of what constitutes best practice with respect to stoping, sinking, and the support of workings, as well as to geophysical prospecting and other phases of mining work. Petroleum and natural-gas producers, the coal operators, and steel companies—all these have their problems, in the solving of which they would like the Bureau's aid, inasmuch as the task is beyond the capability of a single company or individual. Moreover, the health and safety work of the Bureau has been well received; further study is desired, especially as to the effect of certain gases on the miner. State mine inspectors would value the opportunity to come together annually to confer with the Bureau's Health and Safety Branch, if the necessary funds could be provided.

Applied to these many needs, and to others not recited, the appropriation requested by the Bureau must be stretched exceedingly thin to cover all. No one with a glimmering of understanding of the complex character of the mining industry—really a group of industries, each producing an entirely different product and having different problems—would have cut the amount by a single cent.

The present Director of the Budget appears to have concluded that so far as the mining industries are concerned there is economy in starvation. Fortunately the industries whose prosperity and existence are thus attacked and put in jeopardy may hope for a more just measure of understanding and treatment from the incoming administration.

Increased Profits in Mining, and Their Disposition

THE YEAR drawing to a close will prove to have been one of great prosperity for most American industries. A compilation made by Ernst & Ernst, accountants, shows that net profits of 392 companies for the first nine months of 1928 were 11 per cent in excess of those for the same period of 1927. So-called industrial companies gained 19 per cent; public utilities, 12; and railroads did 3 per cent better than last year. Of the industrial group, the most favored were the companies making automobile parts and accessories, with a gain of 50 per cent in net profits, followed in order by leather manufacturers, household-equipment makers, oil producers and refiners, and, fifth, mining and smelting companies, the profits of which were 36 per cent better than last year.

The great improvement in mining and smelting earnings is largely attributable to the improvement in copper prices and increased production, for lead has been consistently below the 1927 average; zinc has exceeded the 1927 average only in the last week or two; and silver prices have not been sufficiently above last year's level to affect profits greatly. Earnings at the present time are well above the average for the first nine months of the year, so more good news may be expected in the year's balance sheets than has so far been released.

Proper disposition of the money now being made in mining should be the subject of careful thought by all mining directors. The stockholders, of course, are entitled to a share, but there is no time like the present to equip plants for economical production; to provide for research work without which progress cannot continue; to see that employees are adequately compensated for work well done; and to add a little to surplus for emergencies and expansions.

Helping to Suppress Tuberculosis Is More Than a Duty

MINING has its particular health hazard, in common with many other industries, and it were futile to ignore the fact that tuberculosis, acquired underground or in surface plants where dust is not allayed, is a cause of preventable illness and mortality. Vigorous combative and educational measures are taken by the leading mining companies, with excellent results; but the parish of *Engineering and Mining Journal* covers a multitude of properties where the risk is recognized, but where no vigorous corrective action is taken. The "skeleton in the cupboard" is left alone, ignorance of simple truths prevails, and the result is misery, suffering, and financial loss to all concerned.

No other ailment has been reduced, in the extent of its ravages on humanity, by the persistent dissemination of educative propaganda, to such an extent as has tuberculosis. Research and medical science have combined to simplify diagnosis and treatment, and no serious illness is more amenable to care and attention. The amazing fact persists, however, that the individual whose health and happiness is threatened fails too often to heed the warnings of approaching trouble. The early symptoms in most instances are unmistakable, but often indiscernible to close friends and relatives—an inexplicable fatigue, loss of body weight, and a persistent though perhaps insignificant cough. A cure is almost certain if early precautions are taken; and no remedial action is too drastic if this can be effected.

In its campaign against phthisis, the National Tuberculosis Association has met with signal success, as statistics indicate. But it cannot seek out incipient invalids. To them and to executives who have the health of their employees at heart we suggest that advantage be taken of the excellent advice contained in circulars and pamphlets obtainable on request from the Association's headquarters at 370 Seventh Avenue, New York City.

As the Christmas season approaches we shall be reminded to use Association seals on our letters. Funds are needed, and a generous response from all mining men should be assurred. To assist in the suppression of tubercolosis in the mining industries is more than a duty.

Has the Engineer Concentrated Too Much on Technology?

THE engineer has wrapped himself around with the technical phases of his work, to the exclusion of its administrative and economic purposes and results. He has failed to sell either himself or his products to the business man or to the banker, being content to remain engrossed in the tricks of his trade. He has allowed the word mechanization to focus in the public eye the machine with which improvements are made and economies are effected, resigning himself to an acceptance in the public mind of a complete disregard of the fact that the machine constitutes merely the "outer clothes" of the mechanical, metallurgical, chemical and psychological work involved in its design, evolution, and application.

The foregoing contentions constitute a few of the "high spots" in an address delivered recently in New York before the Taylor Society by Mr. G. E. Schulz. This organization, be it noted, has for its purpose the helping of industry to approach all phases of management problems—such as production, marketing, finance, industrial relations—in the engineering manner; which means the abandonment of prejudice and guesswork, and haphazard imitation of methods. Instead, it favors the open mind and scientific research experiment, and systematic analysis in attacking such problems.

No one will deny that an opportunity exists for investigation in this direction—for a better understanding of the benefits to be derived from the application of the engineering mind to industrial problems. However, unless the engineer himself, as Mr. Schulz maintains, looks beyond the technique of his work, he will never attract the attention that his work deserves. On all sides one hears that the mechanization of industry has been accomplished; but a cursory investigation invariably shows that equipment and processes are far behind what the market affords or what engineering science has demonstrated as desirable, practicable, and economical. The engineer has scorned psychological methods of attaining his ends, forgetful of the fact that a revolutionary change is the easier accepted because of the complete contrast afforded, leaving less room for argu-

ment than if a minor or cheaper alteration had been suggested. In many instances, the importance of the engineer and his work has been subordinated by deflecting attention to problems of marketing and budgeting economies, which, as Mr. Schulz maintains, is comparable to attaching a fancy harness and a new buggy to an old horse, whereas the need is for a complete motor vehicle, as developed by science and engineering.

Rebuilding Faith in Human Nature

ONE HEARS much about the soullessness of big corporations, the harshness of their highly paid attorneys, and the injustices suffered by those who have no reserves of capital adequate to fight what is usually a strong and heavily financed industrial structure. Frequent complaint comes from the inventor, whose rights are often ignored because of the belief that he is too timid to fight or too poor to meet legal expenses. The general impression created in the public mind is that he seldom gets the reward that would come to him if he were financially capable of enforcing his claims, and that rarely is there evidence of a spirit of fair play actuating the motives of those who utilize and benefit from his invention, although unprejudiced observers may consider fairness in industrial relations a good company policy.

Times are rapidly changing, and an example will prove how illogical such generalizations may be. An American engineer invented a mechanism for drying concentrate, obtaining the necessary patent protection in the United States and abroad. Many foreign countries, including Poland, were not considered as offering sufficient opportunity for use to justify the expense of patenting, the inventor therefore having no protection against the manufacture and use of his apparatus in such countries. But an important metallurgical plant was subsequently erected in Poland, and one of the units was purchased and installed there. It proved satisfactory. More were needed. Economy and necessity dictated that they should be built locally, and this was done. The inventor had no protection in Poland; he was neither entitled to nor expected any royalties there. Despite this, however, the company made overtures to him, stating that it wished to recognize him as the inventor and therefore inquired as to what royalty settlement would be acceptable. The negotiations were concluded without haggling, to the satisfaction of all concerned.

An incident of this character may throw into bolder relief the harsh practices of which one hears so much, but it prompts inquiry as to how many honorable moves such as this are made, and never divulged, on the part of a big corporation and its engineering staff. To the credit of the company in question be it said that it has not sought publicity for the incident related, but *Engineering and Mining Journal* believes that such facts should go on record. The inventor was Mr. H. B. Lowden, of Denver; the machines were constructed and used at the Giesche plant of the Anaconda Copper Mining Company in Poland; and the negotiations, of a type that will do much to preserve a high respect for the company and its methods, were carried through by its distinguished metallurgist, Mr. Frederick Laist.

Rationalizing the Copper Industry from Within

THE rationalization of industry! What does this phrase mean? Is rationalization something to be adopted by industry in general, or is it something to be looked upon with suspicion? The term was first used in Europe soon after the war, in connection with rehabilitation and for the furtherance of a general economic progress—to describe the setting up of rational standards of industrial activity. More recently the term has been used to connote, also, the avoidance of overproduction—an element of industrial depression; the abandonment of trade privileges—a source of industrial discontent; the discouragement of wasteful competition in marketing; and the development of new markets to absorb an increased output resulting from mass-production methods. Such a definition offers little ammunition for those who view with alarm the growing tendency toward the rationalization of industry in this country.

Accepting this broad definition of the term, the copper industry owes much to the rationalization of its practices effected in the recent past. Utilization of a huge excess capacity, developed to fulfill war-time needs, was impossible until consumption could approximate output. The industry acted wisely in not utilizing its total productive capacity at all times and in all seasons. To have done so before an adequate demand had been fostered would have resulted in the suspension of many operating companies at the expense of a few low-cost producers. Instead of a slight depression throughout the entire industry, there would have been a few prosperous camps and the virtual suspension of work in most of the others.

The rationalization of the copper industry is an achievement for which the producers deserve great credit. They can justly take pride in the successful solution of a problem similar in some respects at least to that with which other industries may soon be faced.

As True Now as Then

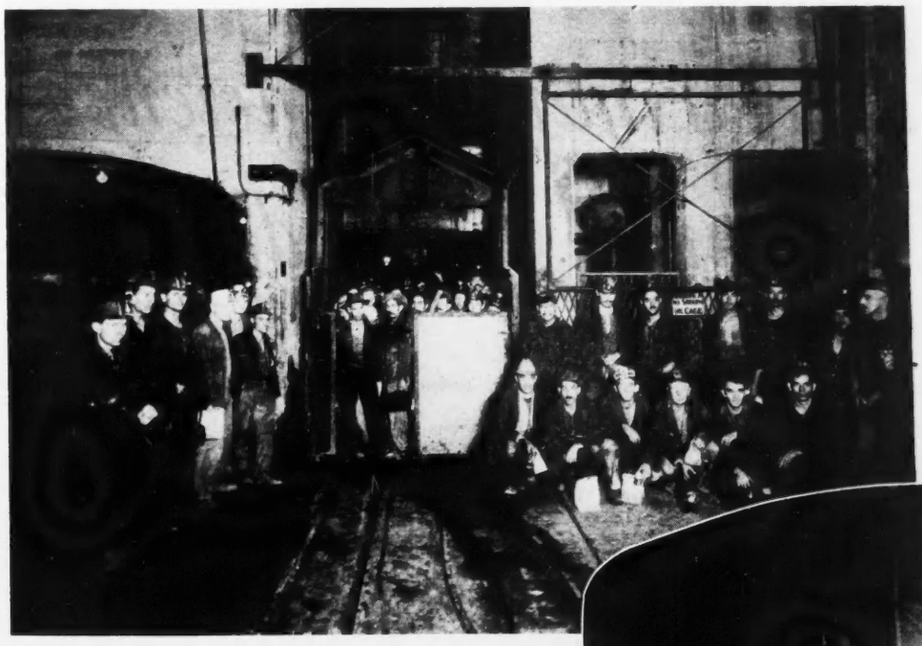
"THE results recorded in this volume demonstrate the existence of vast natural resources and of marvelous energy and intelligence in developing them, and it is natural that other countries witnessing this rapid creation of great wealth and prosperity should seek here its causes. A study of the current history of the mineral industry in all its departments, as recorded from week to week in the pages of the *Engineering and Mining Journal,* will elucidate the solution of this problem."

This was written as an introduction to the first volume of *Mineral Industry,* published in 1892. Since then world copper production has increased from 275,000 tons to 1,500,000 tons; lead from about 600,000 tons to 1,700,000 tons; zinc from 365,000 tons to 1,330,000 tons; and tin from 65,000 tons to 155,000 tons. The story of that growth has been recorded in these pages, and the statement of the first editor of *Mineral Industry,* Richard Rothwell, still holds true. *Engineering and Mining Journal* is the mirror in which the mining industry may see a reflection of its development.

At The United Verde

A recent view of the Clarkdale smelter, in the Verde River valley; the new concentrator is at the left.

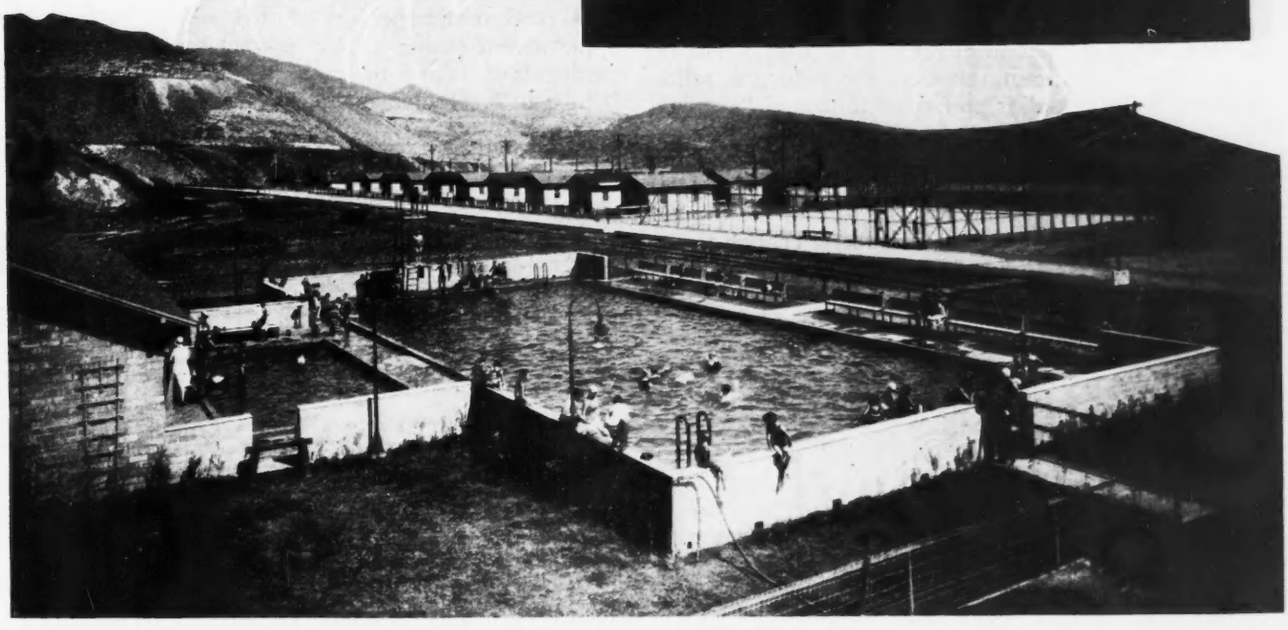
In the oval, the open cut at Jerome



At left, a crew ready for the next shift, at Jerome

At the right, ladle of matte poised for pouring into the converter after skimming is completed

The swimming pool, shown below, is one of the many recreational features provided



Evaluating Grinding Efficiency by Graphical Methods

By WILL H. COGHILL

Supervising Engineer, Mississippi Valley Station, U. S. Bureau of Mines, Rolla, Mo.

IN SOME RECENT STUDIES made preparatory to determining the efficiency of grinding machines, a diagram analogous to a moment and force diagram was used in the calculations so as to visualize the results more easily. Concrete, rather than the usual abstract, efficiency numbers were obtained. This diagram, which shall be termed a "force" diagram for brevity, is here used for determining (1) mean mesh, and (2) mean surface. What follows illustrates the application. Some allied principles are also considered.

Fig. 1—Illustrating the Use of the Force Diagram to Determine Mean Mesh

Mesh	Lever Arm	Per Cent Weight (Forces)	Moment	
4				
6	1	2	2	
8	2	8	16	
10	3	15	45	
14	4	25	100	
				4.63[1]
20	5	20	100	
28	6	15	90	
35	7	10	70	
48	8	5	40	
		100	463	

[1] Position of mean mesh, or resultant.

MEAN MESH

The operator usually likes to express his grinding results in what he calls a reduction ratio. This is generally the ratio of diameter of the coarsest size of feed to the coarsest size in the discharge, and is obviously somewhat uncertain. The calculation of mean mesh enables one to obtain a more significant value for the reduction ratio. The term "mean mesh" is preferable to that of "average diameter," used so abundantly in the literature. "Average" may mean the ordinary or usual, such as an average man or average ability, but "mean" signifies a middle point. Mean diameter or mean mesh focuses the results of the sizing analysis. The term is liberal enough to fit the requirements.

Suppose one is required to find the mean mesh of the following hypothetical sizing analysis:

Mesh	Weight, Per Cent
— 4 + 6	2.0
— 6 + 8	8.0
— 8 + 10	15.0
— 10 + 14	25.0
— 14 + 20	20.0
— 20 + 28	15.0
— 28 + 35	10.0
— 35 + 48	5.0
	100.0

If the percentages of weight are regarded as parallel forces and are plotted on a lever arm hinged at 4 mesh, or any other convenient point along the lever arm, the position of the resultant may be calculated. The diagram is shown in Fig. 1. The sieves are equally spaced along the lever arm. Calculation of the position of the resultant shows that it comes at 4.63, which incidentally is between 14 and 20 mesh. If more precision is sought, the "forces" should be placed in a mean position between the sieves to represent the position of the mean mesh of each size, but such nicety is not required. This method of calculating mean mesh probably gives as true a value for the orthodox "average diameter" as any of the old formulas. At any rate it is so taken in this discussion.

Having demonstrated the use of the force diagram for mean mesh, the solution of an actual problem will be undertaken. Mean surface will be taken up later.

Four sets of Traylor 18x42-in. rolls were crushing 3,400 tons per 24-hour day and requiring 350 hp. The feed was a lead ore with a dolomite gangue. Calculation showed that the rolls were reducing 0.40 tons per horsepower-hour per hour. Sizing analysis of the virgin feed and finished discharge, and the method of calculating mean mesh, are shown in Fig. 2.

The length of the lever arm in the feed diagram is 6.15 and in the discharge diagram, 11.11. The difference is 4.96. Hence the sieve reduction is 4.96 sieves. The reduction ratio may be determined by raising 1.414 —the ratio of the openings of two consecutive sieves— to the 4.96th power, or by interpolating for the sieve openings and taking the ratio. The reduction ratio is about 6 to 1. Reduction ratio is very important to the

Fig. 2—Crushing Data on the Basis of Sieves; 0.40 Ton per Horsepower-hour per Hour

Mesh	Lever Arm	Feed Weight, Per Cent	Feed Moment	Discharge Weight, Per Cent	Discharge Moment
26.67 mm.	1	1.1	1.1		
18.85 mm	2	4.2	8.4		
13.33 mm.	3	17.0	51.0		
9.42 mm.	4	22.5	90.0		
3	5	14.2	71.0		
4	6	9.2	55.2	0.3	1.8
		6.15			
6	7	6.9	48.3	7.8	54.6
8	8	5.4	43.2	22.1	176.8
10	9	3.1	27.9	13.5	121.5
14	10	2.8	28.0	11.1	111.0
20	11	2.0	22.0	8.0	88.0
				11.11	
28	12	1.9	22.8	5.9	70.8
35	13	2.0	26.0	4.4	57.2
48	14	2.0	28.0	4.0	56.0
65	15	1.3	19.5	3.0	45.0
100	16	2.0	32.0	9.9	158.4
150	17	2.4	40.8	10.0	170.0
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operator, and the method of obtaining it presented here is based on the mean of all the sizes.

This method of calculating mean mesh is presented with the full knowledge that it does not provide an accurate measure of the work done. Relative surfaces have to be considered when work is to be determined. The literature on crushing is voluminous, probably the most important contribution is that of John Gross,[1] who determined that the amount of work done in crushing varies as the amount of surface formed. This principle may be expanded so that the force diagram may again be used to systematize the data and to visualize the results when mean surface is considered. In the interim mean mesh has served to determine the reduction ratio.

Mean Surface

The textbooks state as a common principle that when rock of a given configuration is crushed from a given size to a smaller size of the same configuration the total surfaces vary inversely as the lineal dimensions. Elaborate tables have been published showing these relative values. A table of relative surfaces may be assembled by the following reasoning:

Consider alternate standard Tyler screens, 3, 6, 10, 20, and so on, ranging in size so that the dimensions of successive screens decrease by one-half. Let a unit weight of 3-mesh material have unit surface, then the 6-mesh production will have two units, the next four, and the next eight units of surface. This order is shown in Table I.

Table I—Relative Surfaces of Unit Quantity of Material on Alternate Tyler Screens

Mesh	Relative Surface	New Surface
3	1	
6	2	1
10	4	2
20	8	4
35	16	8
65	32	16
150	64	32

The striking thing shown in Table I is that more surface is formed from 35 to 65 mesh than in all the previous crushing. Likewise, the surface at 65 to 150 mesh is greater than the sum of all the numbers above. Hence we arrive at the conclusion that if the sphere which we call our earth were to be crushed, more surface would be made and more work would be required to crush it from 65 to 150 mesh than would have been required in all the preparatory crushing to bring it to 65 mesh. This order of things warrants close scrutiny by advocates of fine grinding. However, the facts have to be faced. Crushing must be done.

Table I may be developed for the intermediate sieves by using the factor 1.414, which is the ratio of the openings of successive screens. The development is included in Fig. 3.

Some of the significant points about the amount of surface produced by grinding have been mentioned. Next will be taken up a calculation where the sizes are weighted according to their surfaces; in the other calculation (Fig. 2) the weighting was irrespective of surface. The same crushing data are used, and the only difference is that the lever arms are proportional to surface. That is, the numbers are in a geometric series. When they are in a geometric series the zero must always be taken at the same point. On the other hand, the series for mean mesh is arithmetical and the zero may be taken anywhere along the lever.

The position of the resultant for the feed (Fig. 3) is 20.4, and for the discharge, 66.8. Hence the amount of unit surface produced by grinding unit quality is 66.8 —20.4 = 46.4 units of surface reduction. Obviously the work is *tons* times *surface*, $a \times b = c$, where

a = units of surface reduction of unit quantity,

b = tons per horsepower-hour per hour,

c = surface tons per horsepower-hour per hour.

Hence by using the factor 0.40 ton per horsepower-hour per hour, as given in the statement of the problem, we

Fig. 3—Crushing Data on the Basis of Surface; 0.40 Ton per Horsepower-hour per Hour

		Feed		Discharge	
Mesh	Lever Arm	Weight, Per Cent	Moment	Weight, Per Cent	Moment
26.67 mm.	1	1.1	1.1		
18.85 mm.	1.41	4.2	5.9		
13.33 mm.	2	17.0	34.0		
9.42 mm.	2.82	22.5	63.4		
3	4	14.2	56.8		
4	5.64	9.2	51.8	0.3	1.7
6	8	6.9	55.2	7.8	62.4
8	11.28	5.4	60.9	22.1	249.3
10	16	3.1	49.6	13.5	216.0
		20.4			
14	22.56	2.8	63.2	11.1	250.4
20	32	2.0	64.0	8.0	256.0
28	45.12	1.9	85.7	5.9	266.2
35	64	2.0	128.0	4.4	281.6
				66.8	
48	90.24	2.0	180.5	4.0	361.0
65	128	1.3	166.4	3.0	384.0
100	180.48	2.0	361.0	9.9	1,786.8
150	256	2.4	614.4	10.0	2,560.0
		100.0	2,041.9	100.0	6,675.4

may make the following calculation:

$46.4 \times 0.40 = 18.56$ *surface-tons* per horsepower-hour per hour.

The product, 18.56, is a concrete number. It has the same specificness as 70 deg. F. or 40 miles per hour. When the position of the axis is standardized—that is, when it is located at a specified mesh—the formula may be used to compare the over-all efficiency of a rock breaker with a ball mill.

These notes are presented with the full understanding that laboratory screens do not work with as much accuracy as the rule implies; irregularities of shapes of grains are not taken into account. In this way the analogy of temperature and of speed may be overdrawn. When one is able to calibrate the actual surface by a method similar to that used for the calibration of a thermometer or speedometer, it will be true.

The sizing analyses used in the foregoing are only approximate, but they serve to demonstrate the principle. The large moment following the 150-mesh discharge in Fig. 3 illustrates the importance of accurate and careful consideration of the finest sizes.

Some consideration will now be given to the feasibility of the methods used in Fig. 3—that is, to the accuracy of the lever-arm values, which vary inversely as the dimensions of the sieves.

Examination of the Lever-Arm Values in Fig 3.

Advance of the science and the art of measuring efficiency of grinding processes seems to have been delayed awaiting a means of measuring surface. Possibly the distance to the goal has been too much magnified. The perspective may have been justified when the material was of flotation or cyanidizing size, but a reasonable way out has been offered where there is not too much material finer than the available screens. The premise

[1]Gross, John; Zimmerley, S. R.; and Swainson, L. J.: "Surface Measurement of Finely Ground Particles and Its Relationship to the Crushing Laws." *Bull.* Univ. of Utah, Vol. XVI, No. 4, pp. 57-76.

would be mathematical and rigid if the sieves gave a true measure of surface. In the past we have not had the temerity to use the sizing analysis as a measure of surface. However, a little more boldness may not be amiss. There are two hard and fast physical laws with which to begin this examination: (1) When a cube is broken into smaller cubes the total *surfaces* are inversely as the lineal dimensions; (2) when a cube is broken into smaller cubes the *number of grains* is inversely as the cube of the lineal dimensions. The same principles apply to other shapes.

When confronted with the results of (1) we have always been abashed, because the cubes do not break into cubes, but into all manner of shapes. Means were not available for finding the actual surface. On the other hand, (2) may be rigidly tested regardless of heterogeneity. If the number of grains is found to correspond with the ideal based on the cube theory (2), it is likely that the surface theory (1) will not lead one far astray. Hence the premise would be that sieves will give *relative surfaces*. Crushers, rolls, and possibly rod mills are supposed to produce flaky grains departing far from cubes in form. Ball mills give grains which are more roundish and more nearly approaching cubes or spheres. These principles will be brought out in another paper. As one warms up to the problem of testing (2) by counting and weighing, one begins to feel that the premise is rational. The conditions must be viewed with sane judgment; the object sought must be kept in mind. On the one hand, the libraries are replete with baffling mathematics and discussions; on the other hand, the busy operator is without a method except to estimate that he has crushed so many tons through a certain limiting size. The problem is to help him get a formula, though it may be crude and of the ox-cart type. The ox-cart served a worthy purpose in its day, and we are in the ox-cart stage in our study of grinding.

The method of calculating surface-tons has been outlined in the foregoing paragraphs. What follows is a discussion of whether or not it is reasonable to use the sieves as a guide to surface measurements. If the number of grains holds reasonably close to the theoretical, without too much irregularity, and the shapes are not of a freaky sort, such as needles, then it is likely that sieves may be used to determine relative surfaces, since they give relative number of grains.

Several writers working from the theoretical standpoint have determined the number of grains when rock is crushed to a certain size, and their results have been put in tabulated form and published. Probably the most available table may be found in Taggart's "Handbook of Ore Dressing," page 492. The table has some value, but it has to be modified for the work at hand. It is deficient because it is based on the scale which varies as the square root of two, whereas the fourth root—or double Tyler scale—is required. Furthermore, it does not apply, because the number of grains recorded are at given sieve sizes, whereas the mean between sieves is required when

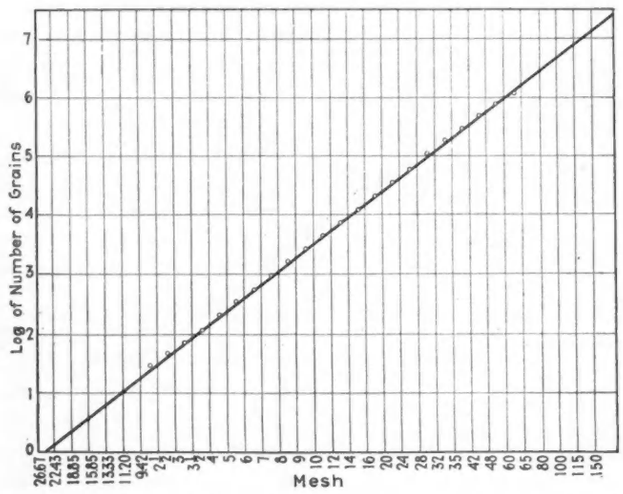


Fig 4—Theoretical and observed number of grains in chert. The straight line represents the theoretical, and the circles the observed.

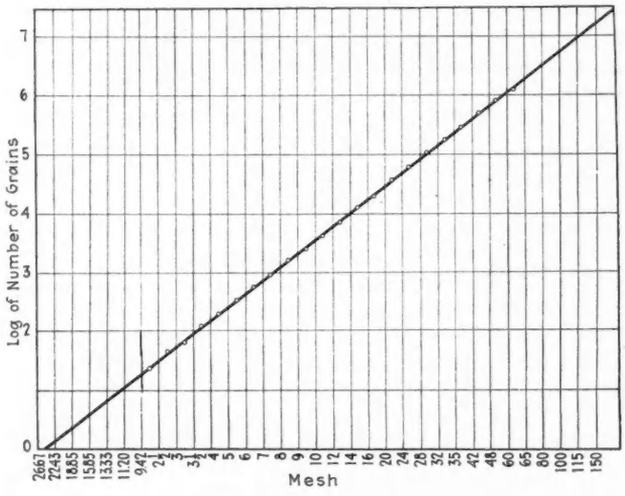


Fig. 5—Theoretical and observed number of grains in dolomite. The observed data are indicated by circles, whereas the straight line represents the theoretical.

counts and practical observations are to be made. The correction is made in Table II, which shows the theoretical number of grains between given apertures when one grain is crushed. Though the original grain may be of any shape, it is assumed that the resulting grains have the same shape as the original. The reasoning and visualizing of this principle may be more easily followed when a cube shape is considered, but the same principle applies when other shapes are taken. Again, the same principle holds when a mixture is taken, for example, of cubes and spheres.

Examination of Table II impresses one with the rapid increase in the number of grains advancing through the

Table II—Theoretical Number of Grains Produced by Crushing From and to a Given Size When the Configurations Are Not Changed

Mesh	Mean Aperture, Mm.	Theoretical Number of Grains	Mesh	Mean Aperture, Mm.	Theoretical Number of Grains
26.67–22.43	24.64	1	16– 20	0.915	19,500
22.43–18.85	20.72	1.68	20– 24	0.770	32,800
18.85–15.85	17.41	2.83	24– 28	0.647	55,100
15.85–13.33	14.64	4.77	28– 32	0.544	92,900
13.33–11.20	12.31	8.02	32– 35	0.458	156,000
11.20– 9.42	10.349	13.3	35– 42	0.385	261,000
9.42– 2½	8.706	22.7	42– 48	0.324	439,000
2½ – 3	7.322	38.1	48– 60	0.272	747,000
3 – 3½	6.169	63.7	60– 65	0.228	1,270,000
3½ – 4	5.176	108	65– 80	0.192	2,110,000
4 – 5	4.347	182	80–100	0.162	3,540,000
5 – 6	3.658	306	100–115	0.136	5,950,000
6 – 8	2.587	864	150–170	0.0963	16,800,000
8 – 9	2.179	1,450	170–200	0.0813	27,800,000
9 –10	1.823	2,470	200–240	0.0701	43,400,000
10 –12	1.529	4,180	240–270	0.0598	70,000,000
12 –14	1.287	7,010	270–325	0.0482	134,000,000
14 –16	1.083	11,800	.....	.....	.....

Table III—Theoretical and Observed Number of Grains From Unit Size of Chert and From Unit Size of Dolomite

Mesh	Theoretical Number of Grains	Chert — Weight Mean Unit Grain = 27.15 — Observed — Weight of 100 Grains in Grams	Chert — Observed — Number of Grains	Chert — Per Cent Deviation	Dolomite — Weight Mean Unit Grain = 29.75 — Observed — Weight of 100 Grains in Grams	Dolomite — Observed — Number of Grains	Dolomite — Per Cent Deviation
2 – 2½	22.7	93.37	29.0	27.7	118.2	25.2	11.0
2½– 3	38.1	59.19	45.9	20.4	66.8	44.5	16.8
3 – 3½	63.7	39.07	69.5	9.1	47.1	63.2	—0.8
3½– 4	108	24.14	112	3.7	24.9	119	10.2
4 – 5	182	13.29	204	12.0	14.9	199	9.3
5 – 6	306	7.70	352	15.0	8.96	332	8.5
6 – 7	516	4.89	555	7.5	5.41	550	6.6
7 – 8	864	2.81	965	11.6	3.39	877	1.5
8 – 9	1,450	1.65	1,640	13.1	1.88	1,580	8.9
9 –10	2,470	1.02	2,660	7.7	1.18	2,520	2.0
10 –12	4,180	0.61	4,480	7.2	0.734	4,060	—2.9
12 –14	7,010	0.36	7,510	7.1	0.427	6,960	—0.7
14 –16	11,800	0.226	12,000	1.7	0.240	12,400	5.1
16 –20	19,500	0.129	20,900	7.2	0.160	18,600	—4.6
20 –24	32,800	0.0735	36,900	12.5	0.0853	34,900	6.4
24 –28	55,100	0.0437	62,100	12.7	0.0518	57,400	4.2
28 –32	92,900	0.0246	110,000	16.4	0.0287	103,600	11.5
32 –35	156,000	0.0159	186,000	19.2	0.0180	165,000	5.8
35 –42	261,000	0.00917	296,000	13.4	0.0109	273,000	4.6
42 –48	439,000	0.00556	478,000	8.9	0.00627	474,000	8.0
48 –60	747,000	0.00349	776,000	3.9	0.00389	765,000	2.4
60 –65	1,270,000	0.00232	1,170,000	—7.9	0.00252	1,180,000	—7.6

finer sizes. The rapid increase in number of grains from sieve to sieve shows how fallacious it would be to use the customary sieve scale—that is, the square root of two.

Counting and weighing of crushed quartzite and dolomite has been pursued far enough to justify what has been said in the foregoing discussion. Data are given in Table III and Figs. 4 and 5. The chert was made clean by sinking out the disseminated grains in a liquid of 2.65 specific gravity. All of the float obtained was clean chert and the density was taken as 2.60. The dolomite was obtained by taking the increment between 2.80 and 2.90 specific gravity. Assigned density was 2.85. A factor depending on specific gravity and an assumed shape has to be applied to the counts. The mean shape or mean volume of the grains is, of course, open to conjecture. A cube is probably the only obtainable shape that will entirely fill the limiting mesh through which it passes, and a sphere that would just pass the same mesh has only one-half the volume of the cube; a cube seems too big and a sphere seems too small. Hence, to obtain the factor, a mixture of spheres and cubes was assumed. Ratio of spheres to cubes was 4 to 3, and the densities of the respective minerals were applied. The result was 27.15 grams for the weight of a unit grain of chert and 29.75 grams for dolomite. The number of grains is found by dividing the factors noted in the foregoing by the observed weight of one grain. This plan gave "observed numbers" reasonably near the theoretical. It must be reiterated that the object of the counting was to see whether the variation through the sizes was regular or irregular. A factor allowing a "deviation" of 100 per cent would have done as well, but it was desirable to have the points in Figs. 4 and 5 fall near the straight line. The figures referred to are on a logarithmic scale; hence the theoretical is a straight line. The regularity with which the points indicating the counts fall so close to the straight line is the evidence sought; the number of grains varies regularly throughout the sizes, and hence it is assumed that their surfaces follow the same regularity. Based on this assumption it may be said that surface varies inversely as the lineal dimension as determined by sieves, and that sieves may be used to determine relative surface. When a better means of determining surface of mill products shall have been obtained, it will take precedence over the sizing method here used.

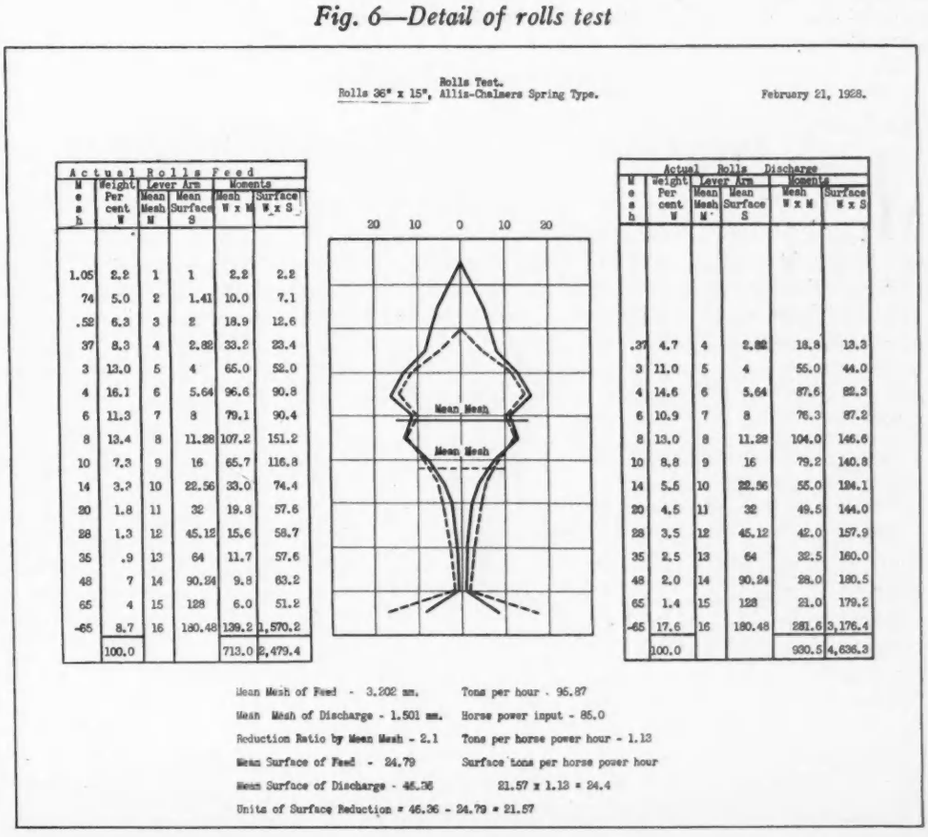
The scope of this study may be extended by reference to the work of Gross and Zimmerley[2]. These authors find cracks in the coarse grains. Of course the sieves do not take these cracks into account, and the results are vitiated to some extent. However, the error may not be serious, because coarse grains are weighted very lightly in the calculations.

A Test on Rolls

The following test on rolls is given for illustration. The ore used was southeast Missouri dolomite. Time samples were taken of the new original feed, the actual circulating load feed, the actual rolls discharge, and the finished screen-undersize. The power also was determined. The four samples gave two sources for calculating the work done: actual feed and actual discharge, versus new feed and finished product. Fig. 6 shows the first, and the second is shown in Fig. 7. The rolls were 36 x 15 inches and ran 60 r.p.m. The new feed was 27.17 tons per hour, and the actual circulating load feed was 95.87 tons per hour. All the data are given in Figs. 6 and 7. The sizing analysis is pictured in the diagrams.

[2]Gross, John; and Zimmerley, S. R.: "Crushing and Grinding Studies of Quartz." *Reports of Investigations* No. 2,880, U. S. Bureau of Mines.

Fig. 6—Detail of rolls test



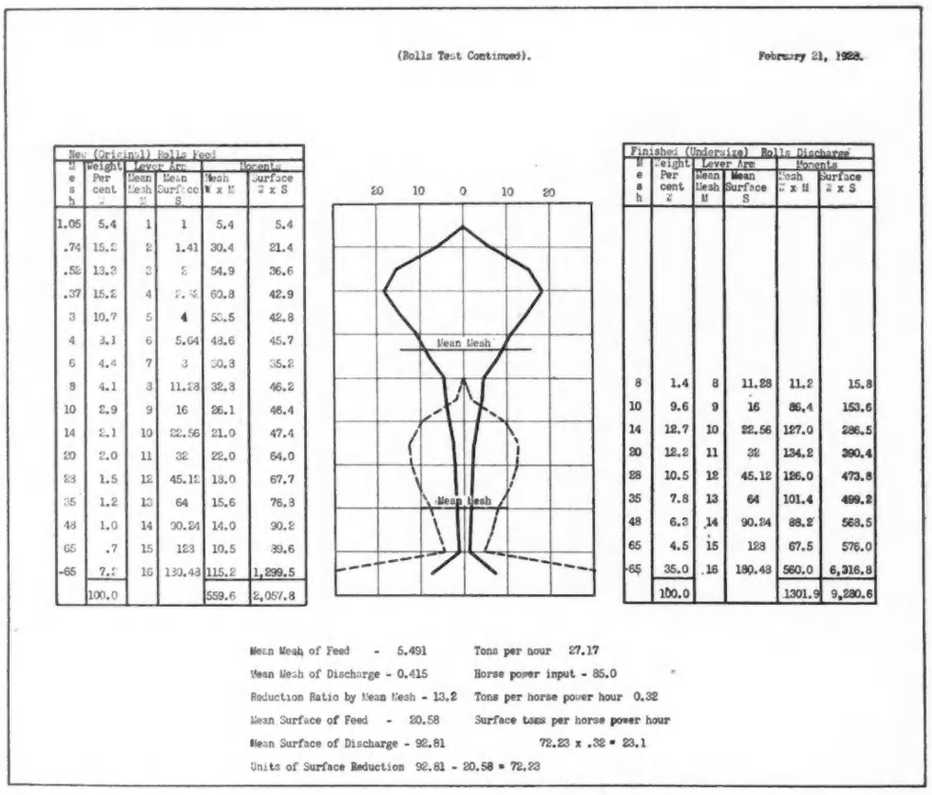
Heavy lines apply to sizing analyses on the left, and broken lines to those on the right. Calculated surface tons per horsepower-hour were 24.4 in Fig. 6 and 23.1 in Fig. 7. Reduction ratio—new feed to finished discharge—was 13.2. The discharge was all through 6 mesh. Other roll tests have been made, but the work has not been carried far enough to determine whether it is profitable to make rolls grind so fine.

The following conclusions have been reached:

1. The data in a screen-sizing analysis may be laid off as hypothetical forces on a force diagram to determine mean mesh and mean surface.

2. For mean mesh the length of the lever arm is an arithmetic series. For mean surface the length of the lever arm is a geometric series varying inversely as the sieve sizes.

3. The mean mesh may be used to determine the reduction ratio obtained by grinding, and the mean mesh surface as the basis for calculating work done.


(Rolls Test Continued).
February 21, 1928.
New (Original) Rolls Feed
Finished (Undersize) Rolls Discharge
Lever Arm
Moments
Mean Mesh
Mean Mesh
Mean Mesh of Feed - 5.491
Mean Mesh of Discharge - 0.415
Reduction Ratio by Mean Mesh - 13.2
Mean Surface of Feed - 20.58
Mean Surface of Discharge - 92.81
Units of Surface Reduction 92.81 - 20.58 = 72.23
Tons per hour 27.17
Horse power input - 85.0
Tons per horse power hour 0.32
Surface tons per horse power hour
72.23 x .32 = 23.1

Mesh	Weight Per cent Z	Lever Arm Mean Mesh M	Lever Arm Mean Surface S	Moments Mesh M x M	Moments Surface Z x S
1.06	5.4	1	1	5.4	5.4
.74	15.2	2	1.41	30.4	21.4
.52	13.3	3	2	54.9	36.6
.37	15.2	4	2.83	60.8	42.9
3	10.7	5	4	53.5	42.8
4	3.1	6	5.64	43.6	45.7
6	4.4	7	8	50.3	35.2
8	4.1	8	11.28	32.8	46.2
10	2.9	9	16	26.1	46.4
14	2.1	10	22.56	21.0	47.4
20	2.0	11	32	22.0	64.0
28	1.5	12	45.12	18.0	67.7
35	1.2	13	64	15.6	76.8
48	1.0	14	90.24	14.0	90.2
65	.7	15	128	10.5	89.6
-65	7.1	16	180.48	115.2	1,299.5
	100.0			559.6	2,057.8

Mesh	Weight Per cent Z	Lever Arm Mean Mesh M	Lever Arm Mean Surface S	Moments Mesh M x M	Moments Surface Z x S
8	1.4	8	11.28	11.2	15.8
10	9.6	9	16	86.4	153.6
14	12.7	10	22.56	127.0	286.5
20	12.2	11	32	134.2	390.4
28	10.5	12	45.12	126.0	473.8
35	7.8	13	64	101.4	499.2
48	6.3	14	90.24	88.2	568.5
65	4.5	15	128	67.5	576.0
-65	35.0	18	180.48	560.0	6,316.8
	100.0			1301.9	9,280.6

Fig. 7—Details of further rolls tests

4. The law that the number of grains varies inversely as the cube of the size crushed to the cube of the size produced was checked by using two ores. Each was sized on double Tyler screens. Twenty-two sizes were made between 2½ and 65 mesh. The ratio between consecutive standard Tyler sieves would have been too great for reliable deductions. Since the law holds true that the number of grains varies inversely as the cube of the dimensions of the size crushed to the size produced, it is probably a fact that the law holds true that the surface varies inversely as the dimensions, and that sieves may be used to determine relative surfaces.

5. The method of working up a rolls test is shown by Figs. 6 and 7.

Determination of Finely Ground Oxidized Minerals by Color

MICROSCOPIC study of extremely finely divided tailings from the treatment of oxidized ores is beset with many difficulties, chief of which is the recognition of such minerals as lead carbonate, lead sulphate, and other oxidized metal-bearing constituents. To render microscopic examinations of such material of immediate value to the mill metallurgist, a method must be developed whereby sight recognition of these constituents is possible.

Principles of optical mineralogy have a limited application, owing largely to the fact that mineral particles less than 0.03 mm. in thickness are exceedingly difficult to determine by standard optical methods. In other words, such particles are thinner than the standard thickness of a thin section. Furthermore, the time consumed in determining each individual particle by the standard petrographic methods is both arduous and of unwarrantable length.

Recent work by R. E. Head and A. L. Crawford, microscopist and assistant microscopist, respectively, at the Intermountain Station of the U. S. Bureau of Mines, at Salt Lake City, on a problem that involved the rapid determination of minerals in a tailing resulting from the treatment of an oxidized ore, indicates that it is possible to stain selectively certain metal-bearing constituents, thus making sight identification possible by virtue of color differences. This method of identification, if perfected, would aid the mill metallurgist materially, as it would enable him to determine quickly the relative quantity of at least two of the common constituents in oxidized lead ores—namely, cerussite and anglesite.

The method developed has been applied successfully on an ore from the Tintic district of Utah, but it has not been proved as yet that interferences to the method may not develop when it is given a broad application. In the present work, either cerussite or anglesite can be selectively stained in the presence of the other. By applying a second treatment, the mineral not stained during the first operation can be stained so as to be readily determined by sight.

Inasmuch as the use of the microscope in determining milling performance is becoming general, perfection of the method will permit work of a fairly accurate quantitative nature to be performed, in either the laboratory or the mill, by anyone not necessarily an experienced mineralogist.

Mineralized Volcanic Explosion Pipes

SECOND INSTALLMENT

By R. T. WALKER

Geologist, United States Smelting Refining & Mining Exploration Company

In Part I, which appeared in last week's issue, Mr. Walker discussed the origin and evolution of volcanic pipes, illustrating the successive steps diagrammatically. In the present installment he devotes his attention to explosion and subsidence calderas. Following this he presents a classification of the three types of occurrences.

Explosion Calderas

MOST volcanic explosion pipes are of relatively small size, ranging from 500 ft. to half a mile in diameter, and the crateriform mounds which they produce at the surface do not differ materially in shape from small volcanic cones. In fact, as has been shown, these mounds are the nuclei of volcanic cones, and if the subsequent volcanic activity is small, there may be little addition to the original mound. But there are some large volcanic explosion pipes, attaining diameters of more than a mile, which, though similar in character and related in origin to the smaller ones, deserve a separate classification because of the peculiar topographic forms which distinguish them from true volcanic cones.

True volcanic cones are mountains of construction, being built up of flows of lava and layers of fragmental ejecta. The crater is relatively small, with a cup-like

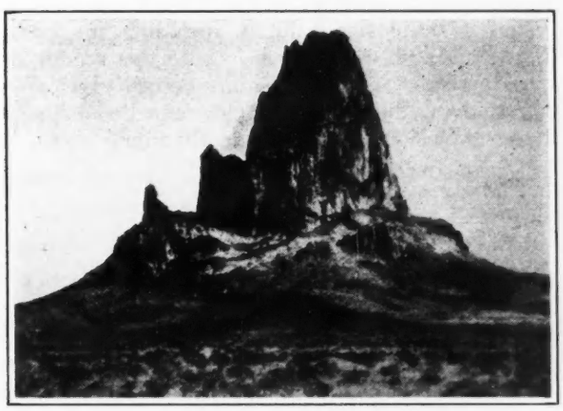


Fig. 5—Agathla Needle, Navajo County, Ariz.
(U. S. Geological Survey Professional Paper No. 93, "Geology of the Navajo Country, Arizona." By Herbert E. Gregory. Plate XIX.)

shape, and is usually situated some distance above the base of the mountain. The giant explosion pipes, however, have very large craters, shaped like a soup-plate or a shallow bowl. They are usually flat-floored and surrounded by relatively low rims, the volume of which about equals the capacity of the crater. The floor of the crater is often below the level of the surrounding country. Craters of this shape and size have been termed "calderas"[1], and, where created by explosions in the manner previously described, will be referred to as "explosion calderas" to distinguish them from "subsidence

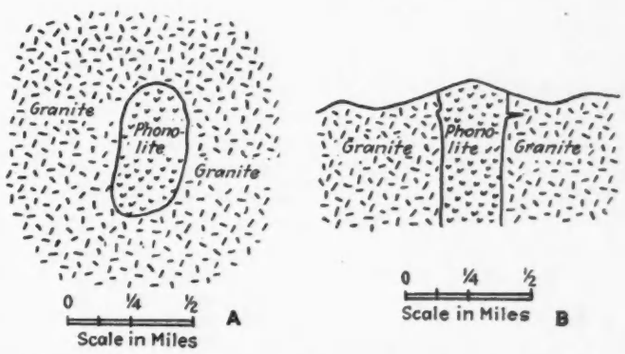


Fig. 6—Plan (A) and vertical section (B) of the Beacon Hill Plug, Cripple Creek district, Colorado.
(From geologic map accompanying U. S. Geological Survey Professional Paper No. 54, "Geology and Gold Deposits of the Cripple Creek District, Colorado," By Waldemar Lindgren and Frederick Leslie Ransom)

calderas," which resemble them in topographic form but have been formed in a different manner. The accompanying diagrammatic cross-sections indicate the distinctive differences in shape between normal volcanic cones and explosion calderas.

Explosion calderas do not seem to originate as such, but to form on the site of some earlier volcanic explosion pipe; and it is probable that they are gradually developed by successive explosions at considerable intervals, each explosion "reaming out" and enlarging the pipe previously formed, or that two or more closely neighboring explosion pipes are combined into one pipe by an explosion which destroys the portion of crust separating them. The formation of an explosion caldera, like that of an explosion pipe, is not necessarily followed by volcanic action; but this happens in most cases, a column of lava making its way upward through the breccia, possibly following a small secondary pipe created by a subsequent minor explosion, and gradually building up a true volcanic cone within the caldera crater or bowl. This "cone-

[1]Pronounced "cahl-day-rahs."

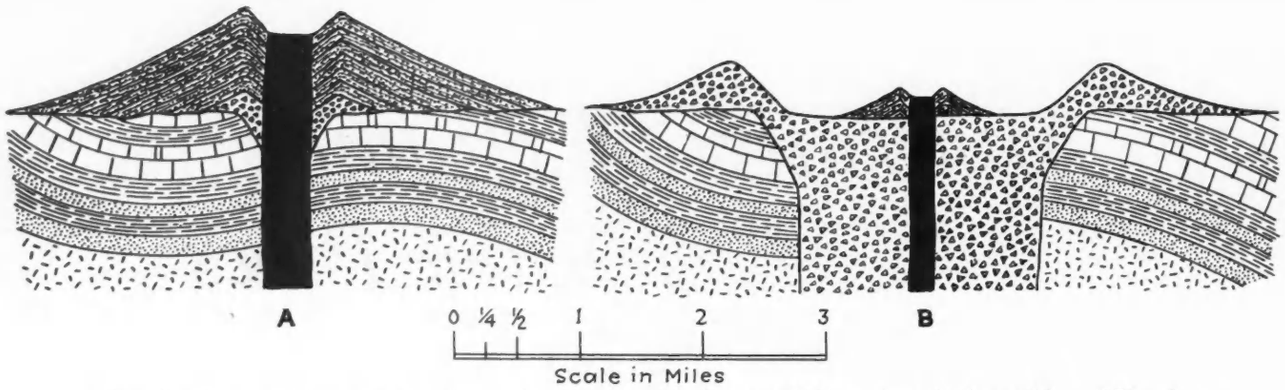


Fig. 8—Comparative cross-sections of normal volcanic cone (A) and explosion caldera (B), the latter showing cone-in-bowl structure. Solid black indicates lava.

in-bowl" structure is characteristic where it occurs, and serves to distinguish calderas, both of the subsidence and explosion types, from true volcanic craters.

A number of explosion calderas have been formed in historic times, and, as is to be expected, the explosions that created them have been much more violent and destructive than ordinary volcanic eruptions. The earliest caldera explosion on record is that of Vesuvius in 79 A.D., which destroyed the cities of Pompeii and Herculaneum. Vesuvius previously existed as a small caldera bowl, between 2 and 3 miles in diameter, and the eruption at that time was an explosive one of similar character, since no lava was emitted, and the cities named were simply buried beneath ejecta of the explosion. Not until 1631 A.D. did true volcanic activity, attended by flows of lava, commence, and since then the present true volcanic cone has been built within the old caldera rim, known as Monte Somma, thus forming a cone-in-bowl structure, although, owing to the relatively small size of the caldera bowl, the cone now nearly fills it.

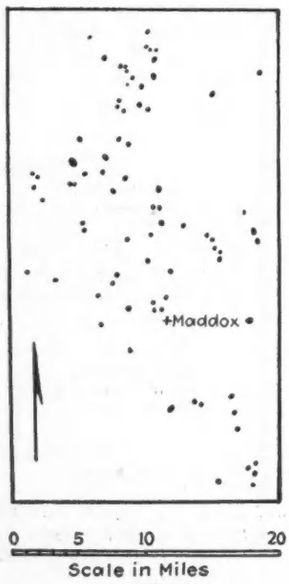


Fig. 7—Showing number and distribution of volcanic explosion chimneys in a portion of the Hopi Buttes volcanic field, Navajo County, Ariz.

(From geologic map accompanying U.S. Geological Survey Professional Paper No. 93, "Geology of the Navajo Country." By Herbert E. Gregory.)

The most violent caldera explosion of modern times occurred in 1883, when the small volcanic island of Krakatoa, in the East Indies, was blown to pieces, and a large circular depression in the ocean floor, some 3 miles in diameter, surrounded by an irregular ring of débris. was formed on its site. Surveys show that two-thirds of the material constituting the original volcano was hurled for distances greater than 9 miles, and that some of the finer dust was carried by air currents over a thousand miles away.

A considerable number of explosion calderas of geologically recent age are known—one of the largest being the lately discovered caldera of Aniakchak[8], in the Alaskan peninsular of Alaska, which has a mean diameter of 6¼ miles. As Fig. 9 shows, this caldera has an interior cone, and thus exhibits the typical cone-in-bowl structure.

The well-known giant craters of the moon, some of which are over 50 miles in diameter, exhibit all the characteristics of explosion caldera, including the cone-in-bowl structure, and probably belong to this type.

Some igneous stocks probably occupy former explosion caldera, the magma having expelled or assimilated the explosion breccia originally filling them, in a

[8]U. S. Geological Survey Professional Paper 132-J. "Aniakchak Crater, Alaska Peninsula," by W. R. Smith.

Fig. 9—Aniakchak crater in the Alaska peninsula, Alaska, an explosion caldera, 6¼ miles in average diameter, with walls 2,500 to 3,000 ft. high, containing an interior cone 2,200 ft. high (cone-in-bowl structure). (U.S. Geological Survey Professional Paper No. 132-J. "Aniakchak Crater, Alaska Peninsula, Alaska," by W. R. Smith.)

manner similar to the origin of volcanic plugs through occupancy of earlier formed explosion pipes, as previously described. This is suggested by the fact that some stocks, as, for instance, those in the Bingham mining district, Utah, have nearly vertical walls and cut directly through sedimentary beds without disturbing their attitude or evidencing any other pressure effects. Such a condition could hardly exist if the magma forming the stock forced its way upward through previously unbroken formations, even with the assistance of magmatic stoping. In other examples an explosion caldera may afford a convenient means of ascent for magma, which eventually, by magmatic stoping and by assimilation, may expand laterally into a large intrusive mass, in which all trace of the former explosion caldera is lost.

Subsidence caldera, in common with explosion caldera, develop only in previously formed volcanoes. They are of two types, which will be described under the names

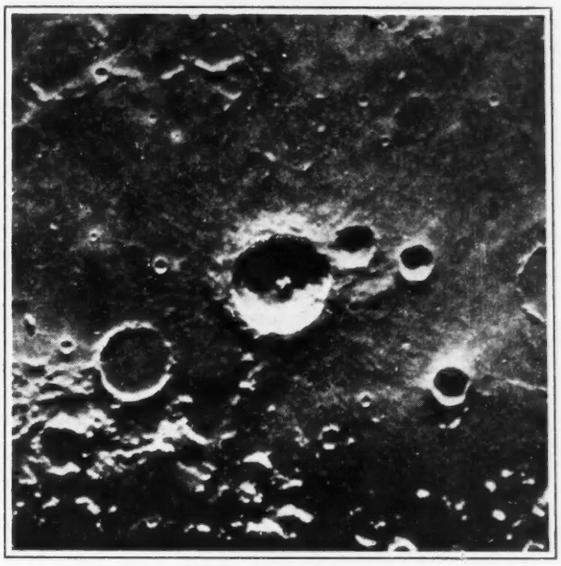


Fig. 10—Telescopic view of the lunar crater Bullialdus, a supposed explosion caldera, 38 miles in diameter from rim to rim, 8,000 ft. deep, containing a central cone, 3,000 ft. high.

Note the neighboring caldera of nearly equal size, almost buried by the ejecta from Bullialdus. (From "The Moon," by Garrett P. Serviss, by permission of D. Appleton & Company)

of "Kilauea type" and "Katmai type." Those of the Kilauea type appear to be caused by a recession of the lava column, such as might occur through issuance from some other connected vent at a lower elevation. Subsidence of the lava column leaves the central part of the volcanic cone unsupported, and it sinks over a greater or less area, depending on the size of the underlying body of magma. The cross-section in Fig. 11 illustrates somewhat diagrammatically the crater of the volcano of Kilauea, in the Hawaiian Islands, which is representative of a number of subsidence caldera in the same locality. The floor of Kilauea crater has both sunk and risen in the manner described within historic times, evidently in accordance with the position of the lava column underlying it.

Subsidence caldera of the Katmai type originate during eruptions of very siliceous lavas, which congeal at higher temperatures than normal. The top of such a

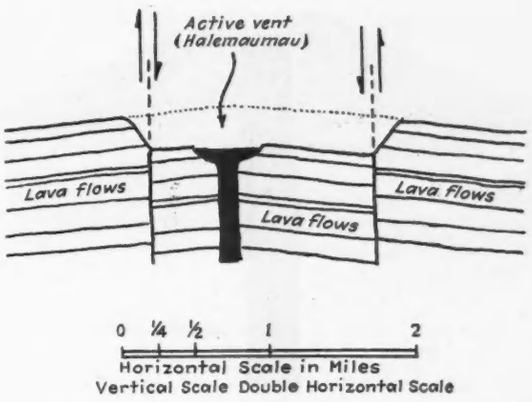


Fig. 11—Diagrammatic cross-section of Kilauea crater, in the Hawaiian Islands, illustrating mode of formation of subsidence caldera of this type. Solid black indicates fluid lava.

lava column in a volcanic vent, cooling to a viscous, doughlike mass through which the magmatic gases cannot penetrate, prevents their escape from below. Consequently, gases accumulate below this barrier, through accessions from lower portions of the magma, until the pressure has risen sufficiently to demolish the obstruction explosively. Coincidently, the subjacent fluid portions of the lava column, through the sudden expansion of the gases distributed through them, are also explosively disrupted to a considerable depth. Usually several explosions take place, at intervals of a few hours, representing the destruction of successive sections of the lava column. Because of the brittle character of very siliceous lavas, the products of the explosions are of small size, ranging from the finest dust to pumiceous fragments a few inches in diameter; and because of their lightness and small size, they are impelled by the force of the explosions and drifted by winds to such distances that, unlike the breccia created in the formation of explosion pipes, only a small proportion falls back into the vent, which may thus be cleared to a great depth. Into the pit thus created, the walls of the crater and vent, shaken by the explosions, tend to slump and cave, involving the summit of the cone, and forming a subsidence caldera.

In a tempestuous eruption in 1912, a caldera pit 3 miles in diameter and 3,700 ft. in depth was formed, in the manner described, in the summit of the volcano of Katmai, in the Alaskan peninsula of Alaska. See Fig. 12. Prior to this catastrophe, Katmai was a normal volcanic cone built up of basic andesitic lavas. The lava of this particular eruption, however, was a very viscous, acid rhyolite, and though none of it issued as lava flows, over 2 cubic miles of this material was expelled from the crater, in successive explosions, as small pumiceous fragments and volcanic ash, which blanketed the country around for as far as a hundred miles in some directions[9]. The slumping of the walls of the crater into the void created by the explosive expulsion of the rhyolitic lava from the vent formed the present caldera pit.

The impressive abyss of Crater Lake, Oregon, which averages 5 miles in diameter and 3,000 ft. in depth, has been described by the U. S. Geological Survey as a subsidence caldera[10], formed, like Kilauea, by the recession of a column of magma beneath it; but the fact that, like

[9] "The Valley of Ten Thousand Smokes," by Robert F. Griggs.
[10] U. S. Geological Survey Professional Paper No. 3, "The Geology and Petrography of Crater Lake National Park," by J. S. Diller and H. B. Patton.

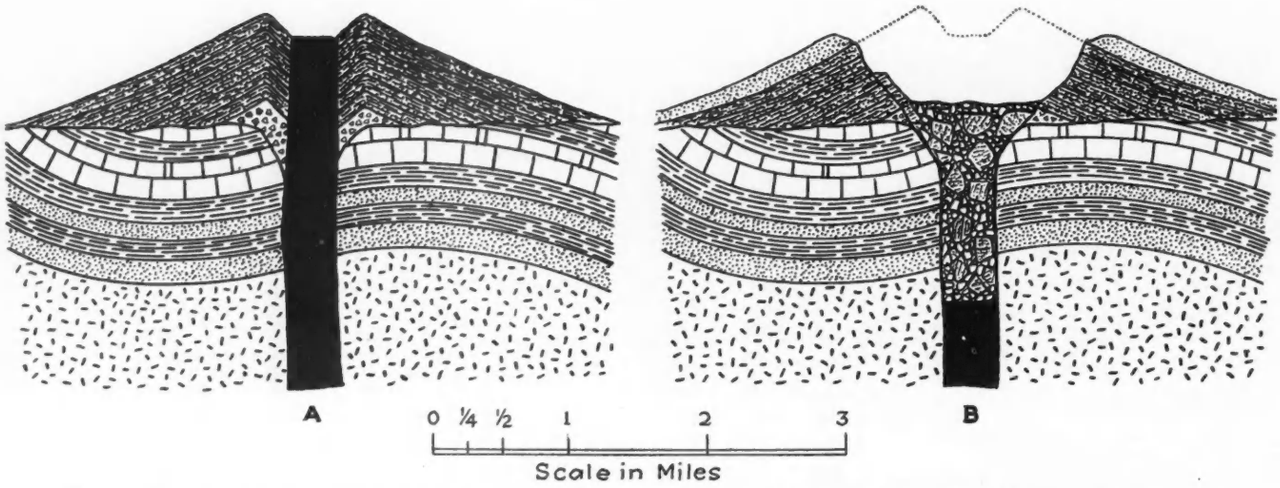


Fig. 12—Illustrating mode of formation of subsidence caldera of Katmai type, by diagrammatic cross-sections, before (A) and after (B) clearing of vent by explosive disruption of upper part of lava column, and slumping of walls of crater and vent. Solid black indicates fluid lava.

Katmai, the last eruption was of siliceous lava, and was accompanied by the expulsion of a vast amount of pumice and volcanic ash, which now surrounds it as a broad belt, suggests that it may belong to the Katmai type, instead.

Distinguishing Characteristics

Not infrequently a subsequent revival of volcanic activity, after the formation of a subsidence caldera of either kind, causes the formation of a small interior cone (cone-in-bowl structure), in the same manner as in explosion calderas. A ready way of distinguishing between them, however, lies in the fact that explosion calderas are surrounded by rims of coarse explosion débris, consisting of fragments, both of the country rock penetrated by the explosion pipe and of whatever volcanic cone may have formerly existed on the site. A subsidence caldera of the Katmai type, on the other hand, has no similar explosion rim, but is encircled by a broad belt of pumice fragments and volcanic ash, derived principally from the lava of particular eruption during which it was formed; and its walls show the effects of interior slumping. A subsidence caldera of the Kilauea type exhibits neither an explosion rim nor a surrounding belt of pumice and volcanic ash, contemporaneous with the formation of the caldera.

Classification

For the purposes of later references, explosion pipes and explosion and subsidence caldera are classified as follows:

A. Explosion pipes (up to one mile in diameter).
   1. Occupied only by explosion breccia.
   2. Explosion breccia cemented by lava, filling the interstitial spaces between the breccia fragments.
   3. Explosion breccia penetrated by one or more dikes or small columns of lava.
   4. Explosion breccia nearly or completely displaced by lava, forming a volcanic plug.

(A further distinction is whether the explosion breccia is original—that is, whether it has been formed by the initial explosion or series of explosions; or whether it is compound, as when, after the intrusion of lava dikes or plugs, subsequent explosions destroy them and mingle their fragments with those of the original breccia.)

B. Explosion caldera (over one mile in diameter).
   1. Occupied only by explosion breccia.
   2. Explosion breccia cemented by lava, filling the interstitial spaces between the breccia fragments.
   3. Explosion breccia penetrated by one or more columns of lava, which have formed an interior cone (cone-in-bowl structure).
   4. Explosion breccia nearly or completely displaced or assimilated by magma, forming a stock.

C. Subsidence caldera (Kilauea type).
   1. Without subsequent volcanic activity.
   2. With subsequent volcanic activity, creating an interior cone (cone-in-bowl structure).

D. Subsidence caldera (Katmai type).
   1. Without subsequent volcanic activity.
   2. With subsequent volcanic activity, creating an interior cone (cone-in-bowl structure).

(To be concluded)

Zinc Occurrence in Tri-State Ores Investigated

THE flakiness of ores may be determined by sizing on square holes and screening on oblong holes, according to experiments conducted by the U. S. Bureau of Mines in the Tri-State zinc district. Producers believed that flaky grains in the jig tailings had a higher zinc content than cubical grains and that losses of zinc in the flotation process were occasioned by this condition. In studying this problem, the new testing method was developed which, according to report, will be valuable in attacking future problems of a similar nature. Rectangular ton-cap screens were selected by trial, so that part of the material already sized on square holes would pass the oblong openings. Obviously, the oversize was cubical and the undersize flaky.

By working with a number of sizes, a comparison may be made, although the trial selections do not permit definite number values to be assigned as in standard sieve analysis. The experiments showed that the cubical rather than the flaky grains have the higher zinc content and that the discharge from grinding rolls was relatively more flaky than that of the ball mill. The experiment indicated that the size of maximum flakiness in the discharge was a function of the size of the feed.

COMMENT AND CRITICISM

Colloid Slime, Finely Ground Ore, and Hydrometallurgical Treatment

Absorption and Adsorption Effects—Elutriation Methods of Separation—Scope for Further Investigation—Effect on Metallurgical Recovery

To the Editor of "E. & M. J.":

The editorial in the issue of Aug. 25 discusses cyanidation losses of gold due to adsorption on the large amount of surface exposed by excessive grinding. Adsorption of gold from a cyanide solution probably takes place on the surface of the ground ore, and it would be interesting to investigate this assumption by sizing the finer-than-sieve size by means of elutriation. It is doubtful if the adsorbed gold on sieve sizes could be accurately determined. Such a determination on finer-than-sieve size without further sizing would not be particularly instructive.

In a milled ore the surface on plus-200 mesh is usually extremely small compared to the surface on minus-200 mesh. Experiments made by the Intermountain Station of the U.S. Bureau of Mines, at Salt Lake City, Utah, on a flotation feed containing 64 per cent minus-200 mesh, showed that only 2.3 per cent of the surface was represented by the plus-200 used, whereas 81 per cent of the surface was accounted for in the finest elutriation product having an average particle diameter of about 1 micron.

By elutriation it is possible to extend the sieve sizes and to separate products down to an average size of 1 micron. The surface represented by these elutriated products can be determined with a fair degree of accuracy. Determinations of the adsorbed gold on the elutriated products, together with such surface determinations, would show their relationship.

The elutriation experiments at the Bureau were made in connection with the study of grinding efficiencies and the determination of the critical size for optimum flotation. This investigation indicated that the useless work in grinding finer than necessary to free the minerals represented an extraordinarily high percentage of the work utilized in grinding. Excessive grinding is not only useless grinding, but also appears to be detrimental in cyanidation as well as in flotation. The elutriation method used by the Bureau has not yet been published, but may briefly be described as follows:

The elutriation tube is 2 in. in diameter and 2 ft. high. A rotor revolving at 80 r.p.m. keeps the charge in a mobile state in the bottom of the tube, so that the upward current has an excellent opportunity to remove the material that should overflow. Besides the control of the speed of the upward current, a constant temperature of the water and the proper dispersion of the pulp are necessary.

The surface of quartz elutriation products from various upward currents has been determined and the average diameter obtained. For the determination of surface and average size of other minerals in the elutriated products corrections according to Stoke's law are made for the density of the mineral, together with a correction for the shape of the mineral particle. On an ordinary ore the surface measurements so far obtained have checked within 5 per cent. Such a check is obtained by comparing the surface in the feed of a classifier with the surface of the products therefrom.

Though the work at the Bureau is primarily directed toward the investigation of grinding, the elutriation of material of a finer-than-sieve size can well be utilized in the study of metallurgical results. It has generally been customary to gage these results by sieve analyses down to 200 mesh. The minus-200 mesh has been considered simply as material of an average size of 37 microns. This has been shown to be wrong, and it has been further shown that the degree of fineness in minus-200 mesh can vary within broad limits.

As there is now available a 400-mesh sieve, sizing can be carried to this limit; although the use of this sieve increases the value of sieve sizing, there still remains a product varying in size from 37 microns to possibly the unit crystal size, in which range extremely large surface areas obtain.

In modern metallurgy, where fine-grinding is so generally adopted, the study of the make-up of the finer-than-sieve size is necessary. By elutriation and surface determinations such an investigation becomes possible and opens up a field for fundamental study.

JOHN GROSS
S. R. ZIMMERLEY

Salt Lake City, Utah

To the Editor of "E. & M. J.":

For some time we have known that there was from 20c. to 30c. in dissolved gold being lost in our tailing. Reagitation of final tailing invariably showed additional extraction. However, when increased time of contact in the mill was given by holding back the pulp during times when the grinding department was shut down, it failed to be translated into increased extraction.

The mill is a standard counter-current continuous decantation plant. An attempt was made to determine the amount of undissolved gold in the pulp at different stages in the process. Composite samples of both pulp and solution at different stages were taken over periods of one week. At the end of the week the solution sample and the solution decanted from the pulp sample were assayed to determine the amount of gold dissolved from the pulp while standing. The pulp samples were washed by decantation and assayed. With a correction for the amount of gold dissolved, this was supposed to give the undissolved gold value of the pulp at the time the sample was taken. Results of these tests were contradictory and inconsistent. In some tests reprecipitation was shown.

Without coming to any definite conclusions, this work was discontinued temporarily in order to make some tests on fine grinding. As those in charge of the tests intended to grind about 90 per cent through 300 mesh, the burden of washing pulps of such fineness by decantation was too great, and so I got a Buechner funnel and arranged to filter and wash the samples by suction. I proposed to take a sample of current tailing, split it into two parts, filter and wash one part, and regrind the other part with barren solution, to 300-mesh or finer, and to filter and wash it. I obtained some very interesting results, but the important fact from the point of view of the present discussion was that by filtering and washing I lowered the tailing 20c. to 30c. per ton without grinding.

We had always determined our dissolved gold loss by assaying the solution decanted from the daily tailing sample and determining the percentage of moisture in the pulp. Then—

$$\frac{\text{Per cent of moisture in pulp}}{\text{Per cent of solids in pulp}}$$

× assay value of solution, equals dissolved gold in tailing. This dissolved gold in tailing has always been kept between 5c. and 10c. per ton. There is, then, a discrepancy between the calculated dissolved gold in the tailing, and the gold actually washed out on the filter, of about 20c. per ton.

The tests were repeated, and the gold washed out in the solution checked against the lowering of the grade of the residues beyond possibility of error.

I recognized three possible hypotheses to account for the discrepancy.

First, owing to aëration on the filter, gold was dissolved that was not released by time of contact with solution or by the agitation in the Dorr agitators.

Second, gold was adsorbed by the faces of some mineral in the pulp, either as metallic gold or as calcium aurocyanide.

Third, high-grade gold solution is trapped early in the system in floccules of colloidal slime. These floccules would have to be impermeable to diffusion of salts in solution by osmotic pressure, tough enough not to be broken up by the agitators, and yet weak enough to be broken down by filtration or by the intensive agitations in the laboratory pachuca tank in which reagitation tests were made.

Filtration tests were made using barren solution wash and compared with water wash. The extraction in each test was the same. Though not absolute disproof of hypotheses first and second noted in the foregoing, one would expect higher extraction with barren solution wash if additional gold was being dissolved on the filter; and, on the other hand, one would expect more extraction of adsorbed gold with a water wash, owing to a change in surface tension.

The thought came to me that if high-grade gold solution were being trapped, this solution would also be high in cyanide and lime.

Our mechanical loss in cyanide and lime had been calculated in the same way as dissolved gold.

$$\frac{\text{Per cent of moisture}}{\text{Per cent of solids}}$$

× pounds NaCN, by titration, per ton solution, equals mechanical loss of NaCN per ton of ore.

$$\frac{\text{Per cent of moisture}}{\text{Per cent of solids}}$$

× pounds CaO, by titration, equals mechanical loss of CaO per ton of ore. Mechanical loss of NaCN per ton of ore calculated from thickener overflow in March by this formula: NaCN, 0.406; lime, 0.987.

Mechanical loss calculated from amount recovered by filtering: NaCN, 0.765; CaO, 2.411. Trapped NaCN, 0.358; trapped CaO, 1.646; trapped gold, $0.20.

As we carry our solutions at about 2.2 lb. CaO per ton and at about 1 lb. NaCN per ton, it is evident that if enough solution were trapped early in the process to account for the trapped lime, and cyanide in the tailing, more than the determined amount of trapped gold would appear in the tailing. This can be explained as regards the lime by the fact that our lime is fed into the tube mill and the tube mill is operated at about 27 per cent moisture, and at this moisture the saturation point of the solution for $Ca(OH)_2$ is greatly exceeded. Therefore, when the pulp is diluted to 80 per cent moisture in the classifier some of the undissolved lime is trapped in the floccules of slime along with dissolved gold and cyanide.

There is some diffusion throughout the progress of the gold cyanide and lime through the mill. Some of the floccules are probably broken up mechanically and form again. But as the difference in strength between the solution inside the floccules and the solution outside the floccules is much greater with respect to gold than with regard to cyanide and lime, the diffusion and consequently the decrease in gold strength is correspondingly greater.

The solution is near the saturation point in lime until diluted with water in No. 5 thickener, and there is very little difference in cyanide strength between the grinding solution and the solution in No. 4 thickener.

After operating the plant with the filter in the circuit for two months, we find that our dissolved gold loss determined by filtering the tailing of the Oliver filter has been reduced to 3c. per ton of ore. Cyanide consumption has been reduced about a third of a pound per ton of ore and lime consumption about 2 lb. per ton of ore.

A very interesting fact that I have noticed both in the plant operation of the filter and in the laboratory filter experiments is that the washing is gradual, the first filtrate being comparatively low, then becoming higher until it reaches a peak, then tapering down gradually to nothing. This is true as to gold cyanide and lime, the curves being about parallel. What I conceive to happen is this: The floccules of slime collapse as the cake is formed on the filter, and each one of these microscopic floccules is surrounded by grains of granular material which afford a freer path for the solution, and therefore it takes more wash to remove the valuable content than would be necessary if the wash were a simple displacement in a homogenous cake. JOHN DIXON.

Kirkland Lake, Ont., Canada.

[The following comments in a monograph on clay and its relation to ore-dressing and cyaniding operations, published in the *Transactions* of the Institution of Mining and Metallurgy, 1915, are reprinted because of their pertinence in this connection:

"In wet processes of ore reduction, and when clay compounds are milled and treated in a cyanide solution containing gold, it would seem probable that an absorption of such solution occurs in the honeycomb cells of the colloid, and that subsequent displacement of this metal must necessarily occupy a much longer time than did its absorption. The absorption is due to direct inhibition, but displacement under normal conditions is probably due to a slow-acting osmotic pressure when the colloid slime is surrounded with wash solution or water. It is also probable that any absorptive equilibrium is only temporary under such conditions, and that cell content varies with the composition of the surrounding medium. . . .

"Metallurgists generally recognize that a considerable time of contact is necessary in washing operations with certain classes of ores; and that theoretical displacement figures do not hold good in practice. Time of wash should not always be based on estimates of gold in solution that is apparently dissolved, as compared with gold associated with the ore that is apparently undissolved. Although metal that has been dissolved may be apparently replaced fairly rapidly by ordinary means, a further abstraction occurs after prolonged contact with wash solution. This fact would furnish additional evidence that the gold solution so recovered is, in part at least, being drawn from the cells of the colloid slime, and not merely washed off the surfaces of the slime particles. . . .

"Metals which cannot be rapidly washed out from colloidal clay may not necessarily be undissolved; it is more than probable that they were, in part at least, first dissolved and later absorbed. This is borne out by concentration experiments on slime residue, which have failed to isolate any portion of the material having a higher metal content than any other."

The facts in the monograph cited indicated the highly absorptive properties of colloidal clay as compared with non-colloidal clay, and evidence was given showing the powers possessed by such clay to retain liquids and dissolved salts. One conclusion reached was as follows:

Adsorption of gold solution may occur during treatment, but the main loss is probably due to absorption. This conclusion is strengthened by the fact that (*a*) non-colloidal clay is only slightly absorbent; (*b*) colloidal clay is highly absorbent, and (*c*) burnt clay (that is, after the colloidal envelope has been destroyed) is almost non-absorbent—EDITOR.]

An Amendment of Mining Law in the United States

To the Editor of "E.&M.J.":

Now that the results of the election are known, the mining profession can plan for the future with a greater degree of confidence. Without doubt an effort will be made within the near future to revise our mining laws. If that comes to pass it is important that such revision take a form that will not make more complicated the present statute.

I suggest that *Engineering and Mining Journal* call for suggestions as to

what changes should be made. In that way one or more new measures may be evolved that could be incorporated in a new statute.

I am inclosing an amendment to the present law. If published it might provoke discussion and criticism which would be interesting and instructive.

E. E. SCHELLENGER.

Blythe, Calif.

An act to amend Section 2329 of the Revised Statutes, so as to promote and facilitate the discovery and development of the mineral resources of the United States, and to prescribe more uniform methods of location and registration of mineral claims.

Be it enacted by the Senate and House of Representatives of the United States assembled, that Section 2329 of the Revised Statutes be, and is hereby, amended so as to permit of all forms of mineral deposits except salines, hydrocarbons, and coal to be located and patented under the following conditions and provisions together with the provisions of the revised statutes not in conflict herewith: After the passage of this act, all forms of mineral deposits except salines, hydrocarbons, and coal may be located and patented in tracts of not more than 160 acres by erecting a monument of stone or substantial post not less than 3 ft. high at or near the point of discovery and posting thereon a notice stating the name of the claimant, the name of the claim, the number of acres claimed, a description by legal subdivisions of not less than ten acres of the tract claimed, the approximate distance to, and the direction of, the nearest section corner or quarter corner of the public lands survey, and the name of the county and state in which the claim is situated.

In the event mineral is discovered on unsurveyed public land, the locator shall, in addition to the requirements mentioned above except the description by legal subdivisions and the reference to certain section corners, erect a monument of stone or a substantial post at each angle of his boundary lines and mark each monument in such a manner that each one can be identified in its relation to the other boundary monuments; also state in the location notice the distance claimed between the several corner monuments and the distance to the boundaries of the claim in a north and east direction from point of discovery.

In the event a locality is discovered where the geological structure and formation indicate that a deposit of valuable mineral may exist which does not evidence itself by surface outcrop or other surface indications, and the discoverer wishes to prospect at depth or by other means test out his discovery, then the ground may be located the same as though there were surface indications of valuable mineral; *provided,* however, that the locator plainly states in the location notice that the location is intended as a "prospecting location." Thereafter the claimant shall have one year from date of location notice to validate the location as a mineral claim by sinking one or more shafts or drill holes or by other means exposing a valuable mineral deposit. If no valuable mineral deposit is exposed within the specified time the claim shall be void.

If, at the time of the discovery of mineral, the locator is not familiar enough with the locality to properly describe his claim, he may post a "preliminary" location notice stating the name of the locator, the name of the claim, the approximate boundaries thereof, the number of acres claimed, and the date of discovery. Within ninety days from date of discovery the locator shall post a new location notice according to the provisions of this act. On or before the expiration of ninety days from date of final location notice, the claimant shall cause to be filed with the Registrar of the United States Land Office of the district in which the claim is situated a true copy of the location notice posted on the claim at the point of discovery. The locator shall also file another true copy of the location notice with the Recorder of Deeds of the county in which the claim is situated. When the claim is situated on unsurveyed land, no location notice shall be filed with the Registrar of the land office.

Whenever a mining claim has been located on unsurveyed land, the locator, to avail himself of all the privileges of this act, shall have his claim surveyed by a United States mineral surveyor, and file the field notes and plat of the survey with the Registrar of the United States Land Office in which the claim is situated.

The annual assessment work on all claims located under the provisions of this act shall consist of work performed in actual development of the mineral deposits within the boundaries of the claim to the amount of a sum equal to $2 for each acre claimed in the location notice. Assessment work shall be performed each year until patent shall have been applied for. On or before Aug. 1 after the expiration of the year in which assessment work is due on mining claims, the claimant shall file proof of the performance of the required amount of assessment work performed on his claim with the Recorder of Deeds of the county in which the claim is situated.

Failure on the part of the claimant of any mining claim located under the provisions of this act to perform one or more of the acts required to be performed hereunder, at the time and in the manner herein provided, shall render the ground claimed in the location notice open to location just as though it had never been located.

Mining claims located under the hereincontained provisions which are situated on surveyed public land or have been surveyed by a United States mineral surveyor, and have had not less than $10 worth of development work performed on the mineral deposits within the boundaries, for each acre claimed in the location notice, shall be entitled to patent upon application. The claimant shall, in addition to the sums incident to the issuing of patent, pay to the Receiver of the United States land district in which the claim is situated the sum of $5 per acre for each acre named in his application.

No mining claim located after the passage of this act shall include or entitle the claimant to any mineral except that embraced by the exterior boundaries described in the location notice as they extend downward, vertically; provided, however, that nothing contained herein shall be construed so as to deprive the owner of a mining claim located previous to the passage hereof of any right that might have been acquired thereunder.

The Commissioner of the General Land Office is hereby authorized and instructed to provide separate record books for the use of the registrars of the several land offices situated in districts in which lands valuable for mineral are found, in which the registrars shall cause to be recorded all mining location notices received by them, which refer to claims situated on surveyed public lands within their respective districts. The Registrar of a district shall receive the same fee for recording mining location notices as the Recorder of Deeds receives in the county in which the claim is situated, and shall issue a like certificate of registration as the aforesaid Recorder of Deeds issues for a like service, and shall at once thereafter return the location notice to the sender at his last known address.

By the Way

Reducing the Element of Chance in Prognosticating

THE difficulty of reporting accurately a market such as has prevailed in copper recently should be apparent to every one with a knowledge of the existing situation. Moreover, the difficulty increases disproportionally as the distance is lengthened between the investigator and the center of activity. During the last few days of October, when the market was occasionally hectic, most market sages and price prognosticators were looking for cover, and "hedging" on the least provocation as the price continued upward.

However, our valued contemporary the Cleveland *Daily Metal Trade* seems to have struck a happy medium in prophesying price behavior that should interest every one who likes to quote that time-worn phrase, "I told you so" —and there are few who do not. In its issue of Oct. 26—the day after the price of copper in New York had been advanced from 15½ to 15¾c. per pound—in a front-page leading article devoted to an analysis of the copper situation, written, presumably, earlier in the week and shortly after the 15¾c. price had been established—the following comment appeared: "There is some talk of a still higher price, perhaps as high as 16c., but there are no indications of a further increase immediately." On page 5 of the same issue, the advance in price to 15¾c. per pound was reported in a column containing the following comment: "Today's condition of the market is in line with expectations as outlined several days ago by *Daily Metal Trade*"—and presumably if the price had remained unchanged one would have been pleased to know that the acrobatics required in patting one's self on the back could have been exercised anyhow! Something seems to be worth investigating here, particularly for the normal variety of "sage" who has difficulty in keeping his average above the 50-50 mark.

H. C. H.

"An engineer," they lightly said;
"Of stolid, unresponsive mood."
With grieving heart but steady hand
He gave our stricken brothers food.

"A bureaucrat," the scoffers cried;
"Routine and rigid, distant, cold."
He spoke and drew the people's hearts
As shepherds do their flocks enfold.

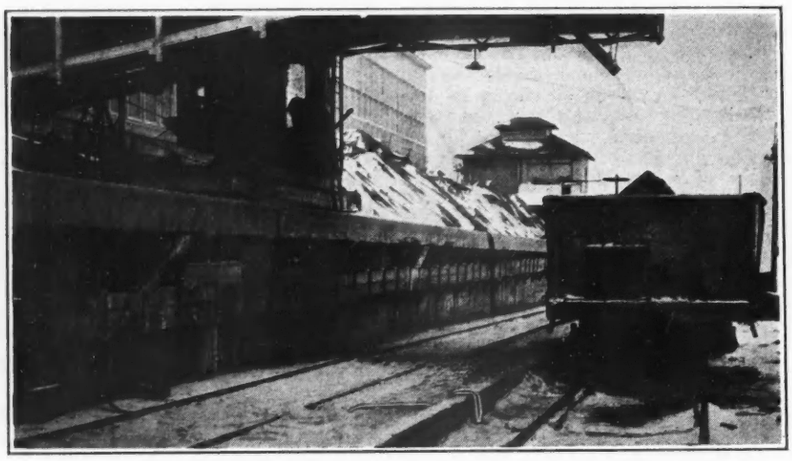
Bring forth the robe that Lincoln wore;
Deck him who knows no pride or place.
God speed the man who mankind knows
But knows no clan, nor creed, nor race!

—B.W.B., in the New York *Evening Post.*

COST-CUTTING INNOVATIONS

ELECTRICAL — MECHANICAL — MAINTENANCE

Rail Heater Saves Labor and Wages



Efficient and easily constructed rail heater used at Magna and Arthur plants of Utah Copper Company

ONE of the best examples of the manner in which all departments of the Utah Copper Company co-operate to reduce costs is typified by the electrical engineering department's development of a rail heater used successfully at the Magna and Arthur plants, where formerly a wet concentrate had to be handled. During loading, water ran down on the rails and in cold weather froze, forming successive layers of ice until a wall locked the car to the track. At such times, four men had to be employed to hew the ice off the track and move the cars.

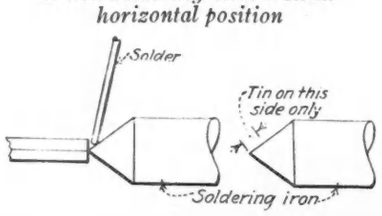
A rail heater was devised with the heating element consisting of ½-in. pipe, 50 ft. long. This was laid along the web of each rail, and, after being insulated to prevent the current from grounding, was fastened to the tie. An old compensator coil was used for a transformer and a current of 9 volts 320 amp. conducted through the pipe. Although the rail does not feel warm when touched, ice does not freeze on it. In this way, by the investment of a few dollars and at a cost of not more than 4c. an hour for electric current, the track can be kept clear of ice in the coldest weather and several hundred dollars in wages saved monthly.

Common-Sense Precaution Saves Solder

SOLDERS for electrical apparatus are generally made in the form of strip or wire to facilitate the soldering operation, writes Dr. James Silberstein. On many occasions it is necessary to hold the soldering iron in a horizontal (or nearly horizontal) position. In such cases only the upper side at the edge of the soldering iron should be tinned, as shown in the sketch, since this results in a considerable saving in solder. If both sides are tinned the result will be that part of the solder runs through the space between the soldering iron and the metal part against which the iron is held no matter how firmly the iron is held against the metal. The part of the solder which runs through and drops on the floor is as a rule much greater than the part which flows into the joint. The floor spillings are of course not lost, since they can be remelted, but they are naturally dirty, and there is danger of getting them contaminated with other metals, which considerably reduces their value. At any rate, they do not have nearly the same value as the solder in strip or wire form. and in shops where much soldering is carried out, the saving made by tinning only the upper side, in those applications mentioned in the foregoing, amounts to quite an item.

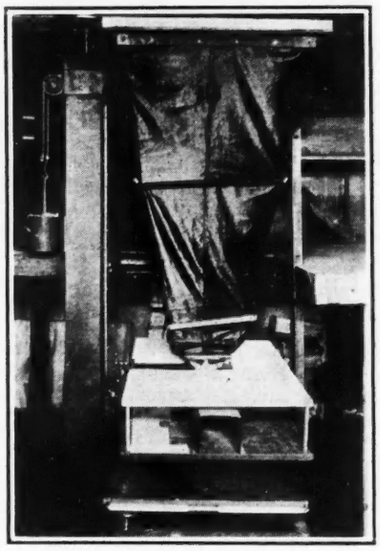
The trend in the electrical industry, as in all other industries, is to increase the efficiency and reduce the cost of apparatus. Everybody who has a chance to compare a motor of today with one of the same rating made twenty years ago is surprised at the difference in weight and size. Several factors must be taken into consideration when determining the size and capacity of electrical machinery. One is the temperature at which the machine is running. If the machine can be allowed to run at a higher temperature, its capacity can be increased. Because the new solder enables electrical apparatus to be run at higher temperatures, one may logically assume that it will have increased application.

When soldering with iron in horizontal position



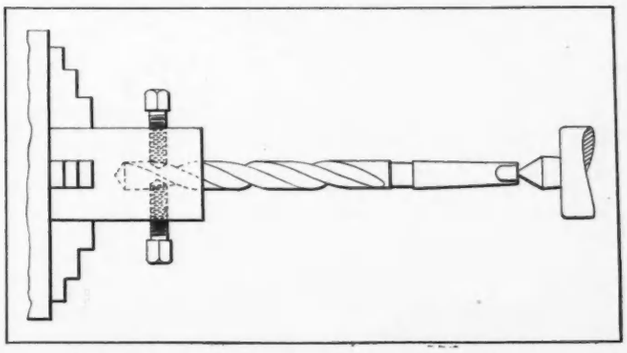
Economical Map-Enlarging

EQUIPMENT for enlarging maps accurately without excessive cost has been devised by C. E. Sims, of the West Penn Power Company, according to *Electrical World*. The machine illustrated was built in a local shop at a cost of $1,400, complete with lens, lamps, and screens. With this machine one man can develop and trace a minimum of four sheets per day, and the cost of making up map sections has been reduced to one twenty-fourth of the cost by pantograph methods.



Tracings of maps to enlarged scale made rapidly and economically by this device

The section of topographical sheet to be traced is pinned to the drawing board at the lower part. Two 500-watt projection lamps, located above and slightly to the side of this topographical sheet, by means of reflectors cast their light upon the section of sheet to be enlarged. A Bausch & Lomb lens is held parallel and a few inches above the section. The



A rapid way of truing taper-shank twist drills

image of the sheet is projected to a drawing board with a glass center 24x36 in., and is traced by a draftsman, who stands on the platform around the machine. The correct scale is obtained by having a line of known length on the topographical sheet and turning the adjusting wheel until the line on the image is of the proper length at the scale desired.

Salvaging Taper-Shank Twist Drills

TAPER-SHANK twist drills are sometimes subjected to severe service, writes H. L. Wheeler in *American Machinist*. The shanks are bent or burred and bruised so that they will not fit the taper sockets, and the tangs twisted off so they will not drive. To salvage these drills, turn the shanks straight, so that they may be used in drill chucks, or turn the shanks down to the next-size taper, if possible. This job is often slighted, owing to the difficulty and time required to chuck the cutting ends of the drills so that they will run true. Certain sizes in eighths and sixteenths, of course, can be held in spring chucks, but the odd sizes in sixty-fourths and thirty-seconds must be handled in some other way.

A simple and easy method of handling a batch of drills of varying sizes is to check a piece of cast iron in a three- or four-jawed chuck. If many drills have to be fixed up in this way, arrange them according to size. Start with the smallest size, and drill or bore a hole in the cast-iron piece, which should first be drilled and tapped for two $\frac{3}{8}$-in. setscrews. Allow it to project from the chuck jaws about 2 in. Drill the hole about 2 in. deep, but not all the way through the casting. Insert the drill in the hole, which is presumed to run true, against the bottom.

If the original center is still intact, the end may be supported by it, if it runs true. If it does not, run the end, just back of where the flutes stop, in the steadyrest. Cut off the broken end and recenter the drill. Then remove the steadyrest and turn the shank straight, leaving the diameter as large as the stock will allow.

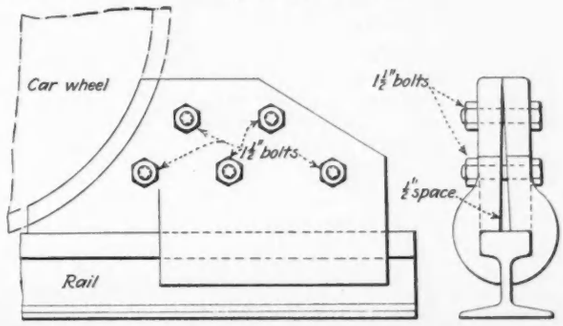
The drill is driven by the two setscrews in the chucked piece, which should enter the flutes of the drill, as shown in the illustration. Enlarge the hole for the next-size drills, and treat each one the same way, taking each size in turn. This is a faster and easier method of truing twist drills than by holding them in a lathe chuck.

This Car Stop Is Cheap and Useful

A SERVICEABLE car-stop clamp can be made by the blacksmith out of steel, as illustrated. It should be built in two halves and bolted together with $1\frac{1}{2}$-in. forged-steel bolts. The halves should have a clearance of $\frac{1}{2}$ in. between them when bolted together so as to have the tension on the end of the clamp against the rail web. It is unnecessary to machine them save for drilling the holes, as the rough forging will answer the purpose.

If the clamp is placed on the track as a permanent fixture, lock washers should be used on the bolts; otherwise this will be unnecessary. The clamp should rest on top of the rail, its end pressing against the web. This is important, as the weight and pressure of the wheel is on the rail and not on the bolts. The end toward the wheel should have the same width as the rail through both halves. This will allow the clamp to seat properly against the wheel.

The clamp can be made cheaply. At the same time it will hold when the car wheel hits. It is especially useful where switching is done.



A rail clamp for service as a car stop

Reducing Cost of Water in Ice Plant

"WE have two 7x7-in. twin-cylinder, vertical-type ice machines with water jackets. As we have no cooling tower, we use city water for cooling, and this water was wasted to the sewer until we made some changes in the system," writes Lawrence B. Brown, of Los Angeles, in the Nov. 6 issue of *Power*. The discharge line from the jackets was run to a 50-gal. tank in the boiler room that has been in the plant for a couple of years and never used. This tank was connected by a $\frac{3}{4}$-in. line to our feed-water heater, and this allowed us to use the jacket water, formerly wasted, as makeup feed for the boilers.

"We also made a change in the cooling system for the ammonia condenser. The cooling water was taken from the house tanks, on the roof (elevation 150 ft.). The water is supplied in these tanks by a centrifugal pump, belt-driven from the motor that drives the ice machines. In the summer months this water was used over and over again, without a chance for cooling, and when it became too warm for use in the condenser, it was necessary to use water direct from the city main, and waste it to the sewer. To eliminate this waste we made a 2-in. connection from the soft-water side of the water softeners, to the city water connection at the ammonia condenser. The softened water is first passed through the condensers, then through the pump to the roof tanks. If more water is drawn from the tanks than is being passed through the condenser, the main house pumps cut in and supply the difference. In this way we are able to save the cost of the water that used to be wasted, and also the cost of the electric power for pumping the makeup water to the roof tanks with the house pumps."

Carpenter's Horse Made From Scrap Pipe

ALMOST every shop has use for the so-called "carpenter's horse." By welding together scrap lengths of pipe, substantial horses, that can be employed for any purpose, can easily be made, suggests James Lewis in *American Machinist* of Nov. 15. Four lengths of pipe about 3 ft. long (preferably 2 in. in diameter, but any size over 1 in. will do) and one length about 4 ft. long are needed for each horse. The pipe is cut to length and the ends are beveled for welding by means of the oxy-acetylene cutting torch, which is also used to cut off the ends of the legs, so that the horses will stand without rocking. After the legs have been cut to the proper angle, they are welded to the crossbars with fillet welds. No cross braces are necessary. A durable work bench for the shop can be made by laying planks across the tops of two or three of the horses.

Personal Notes

THOMAS F. COLE, of San Diego, Calif., is in New York.

D. L. H. FORBES, general manager of Teck-Hughes Gold, was in New York recently.

E. N. GOODLETT is in charge of operations at the Ironclad mine, Cripple Creek, Colo.

HORACE GRAHAM, manager of Caracoles Tin Company, in Bolivia, is in New York for a short time.

M. H. SEELEY is investigating a number of properties in the Thunder Bay district, northwestern Ontario.

HENRY WYMAN, manager of Minerva Mining, in Aguascalientes, Mexico, is in New York on company business.

PHILIP L. FOSTER sailed on the "Berengaria" for London on Dec. 14. He expects to be away from New York for two or three months.

J. M. CONNELL, director of Noranda Mines, has been elected a director of Abana Mines, which owns properties in northwestern Quebec.

J. S. MCKAY has been appointed to succeed J. C. ARCHIBALD as general manager of Pittsburgh Vetagrande Mining Company, operating in Zacatecas, Mexico.

G. CHESTER BROWN, secretary of California Metal and Mineral Producers Association, was at the American Mining Congress convention in Washington last week.

A. M. HOWE, inspector of state batteries and chief inspector of machinery in Western Australia, has been appointed state mining engineer in succession to A. MONTGOMERY.

CHARLES G. WILLIAMS, general superintendent of Hollinger Consolidated, and VICTOR H. EMERY, mine superintendent, have resigned and expect to enter consulting practice in Toronto.

T. H. JENKS is in charge of development work at the Gallic-Vulcan mining properties in the Lake City district of Colorado. The properties have recently been taken over by business men from Davenport, Iowa.

Dr. E. U. VON BUELOW spoke before the Colorado Engineering Society at Denver on Dec. 3 on "The Practical Side of Geophysics." The meeting was held under the auspices of the Colorado Scientific Society.

K. B. HEISEY, mining engineer, of Kirkland Lake, Ont., has been appointed consulting engineer for the Kirkland Gold Belt Mines, Ltd. The company is developing a gold prospect in the eastern section of the district.

C. B. KINGSTON, consulting engineer to Anglo-American Corporation of South Africa, in Northern Rhodesia, has returned to Broken Hill after an extended trip through Southern Rhodesia and the Union of South Africa.

A. R. SCHLOESSER, mining engineer, has established headquarters at Guazapares, Chihuahua, Mexico. His purpose is to make a detailed study of the ancient Spanish mining camps of the district of Arteaga, which once produced large quantities of silver and gold, but which have been abandoned and practically forgotten for many years.

A. R. SCHLOESSER

S. C. THOMSON, mining engineer and managing director of Noranda Mines, revisited the Rand recently, where he was well known several years ago when he was consulting engineer for S. Neumann & Company.

Dr. DORSEY J. PARKER, supervising engineer of the U. S. Bureau of Mines, who has been making his headquarters at Berkeley, Calif., is now making his home in Salt Lake and has offices in the new Mines Building of the University of Utah.

R. H. CLELAND has been appointed inspector of mines for the Ontario government, to succeed George E. Cole, who recently resigned. He will be in charge of the Porcupine district. Mr. Cleland is a graduate of Queens University, Kingston, Ont.

WALTER X. OSBORN, superintendent of the new tungsten plant being erected in Globe, Ariz., by the E. C. O'Brien Company, has returned to Globe from Evanston, Wyo., where he was called to attend the funeral of his twelve-year old son, Victor Osborn.

Prof. G. D. SHALLENBERGER, chairman of the department of physics at the University of Montana, Missoula, Mont., spoke before the Montana Society of Engineers at the society's December meeting in Butte on Dec. 10. His subject was, "The Cosmic Rays and the Origin of Matter."

GEORGE BECKER, formerly superintendent of the Little Johnny mine, at Leadville, Colo., and who was at one time engaged with the Tomboy mine, in the Telluride district, has been appointed Colorado state mining inspector for district No. 1, filling the vacancy caused by the death of Thomas R. Henahen.

Dr. W. R. CRANE, research engineer for the U. S. Bureau of Mines, who has been conducting research work at the Michigan School of Mines at Houghton, has transferred his activities to Tucson, Ariz., as a base. He will reside in Salt Lake. Dr. Crane is studying ground subsidence. He recently completed a report on the history of operations in the Michigan copper district.

J. MURRAY RIDDELL is now associated with Crowell & Murray, Inc., consulting mining engineers, Perry-Payne Building, Cleveland, Ohio. For the last ten years Mr. Riddell has been employed by the Corrigan, McKinney Steel Company as reporting engineer, assistant district superintendent of its Menominee Range iron ore mines, and general superintendent of the company's Kentucky coal mines.

J. J. SEDERHOLM, director of the Geological Commission of Finland, has been awarded the Penrose Medal of the Geological Society of America for his contributions to the study of the Pre-Cambrian era. Dr. Sederholm has evolved in detail the complete geological succession of the Pre-Cambrian period in Finland, and this has become the standard with which Pre-Cambian areas in other parts of the world are now compared. The award will be made at the annual meeting of the Geological Society in New York, Dec. 26 to 29. This is the second award to be made of the medal, the first having been made to the late Prof. Thomas Chrowder Chamberlain, who died recently, for his research into the origin of the earth.

Major JAMES C. MCMILLAN, mining engineer and inspector of mines for Cobalt and Kirkland Lake, has been appointed to make a special study of the geology of Uruguay by the government of that country and has been granted leave to do so by the Ontario Department of Mines. He will leave for Uruguay in January. Major McMillan is a graduate of Toronto University and has had a long and varied experience in geological exploration and mining. In 1908 and 1909 he acted as geologist in the Canadian Arctic expedition, under Captain Bernier. E. C. KEELEY, of Banff, Alberta, will succeed Major McMillan as inspector of the Kirkland Lake and Cobalt districts. He is a graduate of Queens University.

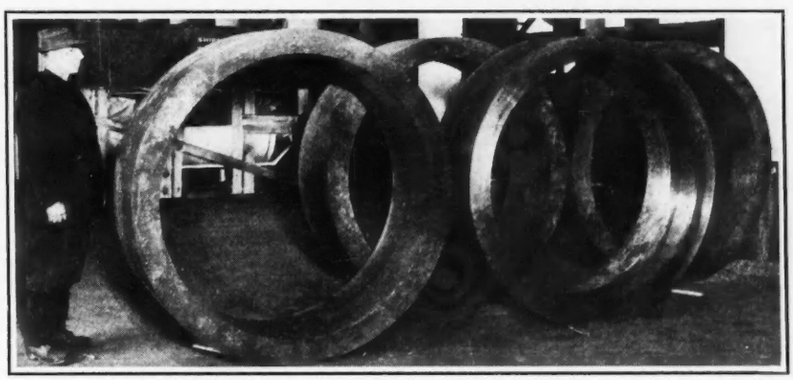
OBITUARY

GEORGE C. COLLINS, mining engineer, died at San Bernadino, Calif., on Nov. 30. He was 47 years old.

INDUSTRIAL PROGRESS

Electric Furnace Indispensable in Modern Mine Foundry

Time-Saving Innovation Effects Substantial Economies, Utilizing Scrap and Producing High-Grade Castings



72-in. roll shells made by the Wallace Foundry at Vancouver. Shells like these are now made by the Britannia Mining & Smelting Company from plant scrap, which is melted in a 600-kw. Greene arc furnace

By Albert E. Greene
Consulting Engineer, Seattle, Wash.

THE combination of a breakdown emergency, a supply of scrap iron or steel, and available electric power is not an unusual occurrence. Mine and mill operations necessitate an ample supply of renewal castings, or means to manufacture these. The direct and indirect costs of an adequately stocked storeroom are high, and the result of a breakdown of a part that cannot be replaced from stock is often a serious expense. One of the best insurances against loss of operating time and an unexpected rise in operating expense—the result of delay—is the provision of an electric furnace in the foundry which is also available for the cheap manufacture of renewal parts from iron and steel scrap. Such parts vary in size from large crusher roll shells to small grinding balls.

An example of the successful use of electricity in mine foundry work is seen in the operations of the Britannia Mining & Smelting Company, of British Columbia. Roll shells have constituted an important requirement. Formerly, such renewal parts, weighing as much as 6,000 lb. apiece, were brought from England, although some have been made at the Wallace Foundry, at Vancouver, B. C. These are all now manufactured on the property from plant scrap, which is melted in a 600-kw. Greene arc furnace. The quality of the resulting casting is as good as or better than that bought formerly, and a significant saving in expense has resulted.

In making these roll shells the company has found that by adding an inch to the outer diameter the life of the part was increased considerably, with a small increase of manufacturing cost. Reduced labor charges and lowered time loss are also attendant advantages. The shells are usually made of high-carbon chrome steel and are well annealed. This grade of alloy steel is also suitable for many other types of wearing parts; it combines strength and toughness with resistance to wear.

Cast iron can be made by the use of the same furnace, without the purchase of pig iron. The Britannia company and the Wallace Foundry make all cast iron from steel and iron scrap. Cast iron is used by the Britannia company for making hard-iron balls for use as grinding media. Such balls are usually made of hard cast iron and of steel; the hardest metal obtainable lies between iron and steel in composition. The Wallace company recently made two large crusher jaws from electric-furnace metal, one of which is shown herewith. It weighed about 8½ tons when cleaned, and required 21,000 lb. of steel scrap. The heat was made in a three-ton Greene furnace, using about 1,100 kw. The operation took about five hours, and the energy consumed was about 504 kw.-hr. per ton of scrap melted.

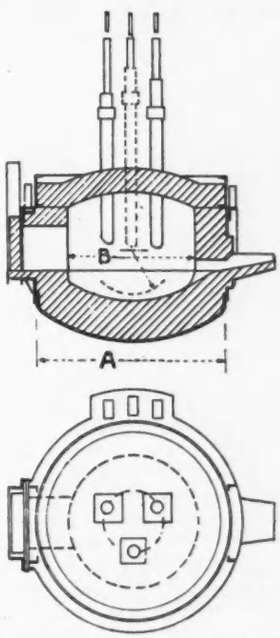
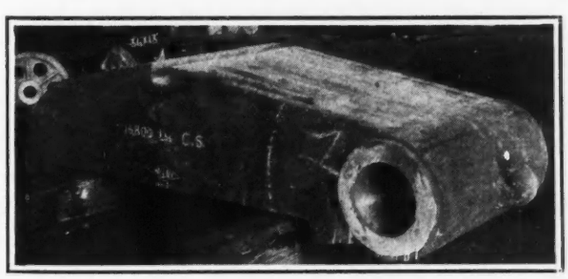
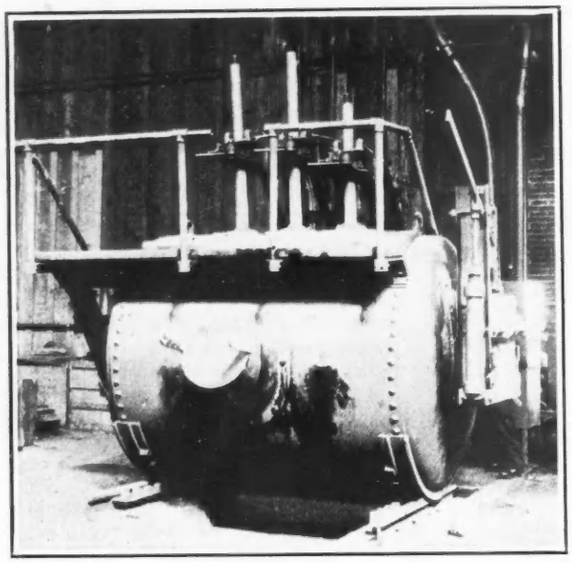


Diagram of fast-melting furnace



Crusher-jaw casting of 8½-ton crusher made by the Wallace Foundry Company, of Vancouver, B. C., for the Granby Consolidated Mining & Smelting Company, of British Columbia, using a Greene electric furnace.

A high-voltage special transformer is not needed in the operation of a Greene furnace, which operates direct from 220 volts, 3 phase, or 440 volts, 3 phase, by using a Greene voltage-control apparatus. The 500-lb. Greene furnace will easily hold 1,500 lb. and can be made to hold 2,500 lb. by overloading. A furnace of this size will operate on low power supply as well as on high power supply. This is an advantage



An electric furnace of the rolling cylinder type which is operated under the Greene patents

when power beyond a relatively small amount cannot be spared. Thus the 500-lb. Greene furnace will operate on 100 kw. More time is required than if more power were available, because it takes a certain amount of energy to melt the metal, and this can be put in slowly or quickly. Although slow melting is not so efficient as is fast melting, it is advantageous at times to be able to melt slowly rather than not at all.

The Greene patents, under which these furnaces operate, indicate an extremely simple and effective method of melting, as well as the production of steel that has been thoroughly deoxidized. The furnaces are equipped to supply multiple-voltage control of the arcs; and the more recent installations are being equipped with a voltage-control apparatus that obviates shutting off the power while the voltage is being changed.

Both mine and mill usually require castings of a standardized character. The foundry problem is therefore a simple one. Costs of electric-furnace operation are exceedingly low, and under certain conditions the plant has saved its own initial cost within a year.

PATENTS

EARTH-BORING DRILL. No. 1,692,793. Nov. 20, 1928. Clarence E. Reed, Wichita, Kan.

TUNNELING MACHINE. No. 1,693,954. Dec. 4, 1928. Howard E. Marsh, Lompoc, Calif.

ORE-TREATING FURNACE. No. 1,693,702. Dec. 4, 1928. Francis M. Simonds, New York, N. Y.

ROCK DRILL. No. 1,692,934. Nov. 27, 1928. Elmer G. Gartin, assignor to Sullivan Machinery Company.

ROTARY DRILL. No. 1,693,017. Nov. 27, 1928. H. D. Bartholomae and William A. Bartholomae, Jr., Los Angeles.

ROCK DRILL LUBRICATOR. No. 1,693,203. Nov. 27, 1928. A. H. Katterjohn, assignor to Gardner-Denver Company, Quincy, Ill.

DETERMINING CORE DIP. No. 1,682,885. Nov. 27, 1928. John E. Brantly, assignor to Atlantic Oil Producing Company, Philadelphia.

ELECTRIC FURNACE. Nos. 1,692,478-9. Nov. 20, 1928. Jacob Weintz, assignor to Strong, Carlisle & Hammond Company, Cleveland.

RECORDING OPTICAL PYROMETER. No. 1,692,923. Nov. 27, 1928. O. H. Blackwood, assignor to the Koppers Company, Pittsburgh.

MUFFLE FOR SINTERING MACHINES. No. 1,692,976. Nov. 27, 1928. J. C. Devick, assignor to American Smelting & Refining Company, New York.

MAGNETIC PULLEY FOR PAN CONVEYORS. No. 1,692,613. Nov. 20, 1928. John P. Bethke, assignor to Magnetic Separator Company, Milwaukee.

MAGNETIC SEPARATION. No. 1,692,590. Nov. 20, 1928. Roswell H. Stearns, assignor to Magnetic Manufacturing Company, Milwaukee.

PRODUCING PURE LEAD FROM CRUDE LEAD SULPHATE. No. 1,691,841. Nov. 13, 1928. Réne Daloze, Brussels, Belgium.

Slime from lead chambers is given as an example of the crude lead sulphate referred to in the patent.

FURNACE FOR DECOMPOSING ALKALI-METAL CHLORIDES. No. 1,692,175. Nov. 20, 1928. Julius Kersten, Bensheim, Germany.

This covers a furnace for the decomposition of alkali metal chlorides by steam in the presence of silicates in a molten mass.

SULPHUR TREATMENT. No. 1,692,422. Nov. 20, 1928. J. W. Schwab, assignor to Texas Gulf Sulphur Company.

This covers a method of purifying sulphur contaminated with hydrocarbons, by agitating it, while molten, in the presence of anhydrous aluminum chloride and separating the molten sulphur from the combined impurities.

AIR COMPRESSOR. No. 1,692,263. Nov. 20, 1928. F. D. Holdsworth, assignor to Sullivan Machinery Company.

With this patent several others covering air-compressing machinery and granted to various individuals and assigned by them to the Sullivan company are recorded in the same issue of the "Patent Gazette."

ZINC-CADMIUM METALLURGY. No. 1,691,-714. Nov. 13, 1928. Oscar Gerlach and Nils Ostman, assignors to Matthiessen & Hegeler Zinc Company, La Salle, Ill.

This covers a process of removing cadmium from oxygen containing zinc ore by subjecting the ore to steam and a reducing agent sufficient in amount to reduce the cadmium but not a material part of the zinc contained in the ore at a temperature at which the compounds of both cadmium and zinc reduce.

APPARATUS FOR REDUCING METALLIC OXIDES. No. 1,692,587. Nov. 20, 1928. William H. Smith, assignor to General Reduction Corporation, Detroit, Mich.

This covers iron-ore-reducing apparatus comprising a plurality of retorts arranged in a row with means between them to provide preheating, reducing the cooling zones, and a heating means to heat each reducing zone to a substantially uniform reducing temperature. Patent No. 1,692,588 covers the method involved.

DIRECT REDUCTION OF IRON ORES. No. 1,691,274. Nov. 13, 1928. Henning Gustav Flodin, and E. G. T. Gustafsson, assignors to Hampus G. E. Cornelius, Stockholm, Sweden.

This patent covers a direct electric reduction process for producing dense iron or iron alloys from oxide iron ore containing a metal capable of deoxidizing and degasifying iron, with a charge composed of such ore in a finely divided state and carbonaceous material. Patents Nos. 1,691,272 and 1,691,273 are allied to it.

ELECTRIC SMELTING. No. 1,691,439. Nov. 13, 1928. E. G. T. Gustafsson, assignor to Hampus G. E. Cornelius, Stockholm, Sweden.

This patent covers the following steps in the manufacture of metals in electric furnaces under practically continuous operation: charging the furnace with a metalliferous charge; smelting with electric heat while forming metal and slag; emptying the furnace to bare the bottom; reintroducing a quantity of slag substantially in its original tapped condition to protect the furnace bottom against the action of the electric arc; and finally starting the charging for the next heat.

GEOPHYSICS. No. 1,692,530. Nov. 20, 1928. Theodore Zuschlag, assignor to The Taumac Corporation.

This covers, in the art of locating ore-bodies by observing the characteristics of subterranean electric currents, the method of generating subterranean currents by causing a flow of current between spaced points, causing another opposite flow of current of equal magnitude and adjacent to and parallel with the first-mentioned flow, and grounding said currents at spaced points in such a manner as to produce subterranean currents.

CONCENTRATION. No. 1,691,310. Nov. 13, 1928. E. H. Snyder and W. D. Green, assignors to Combined Metals Reduction Company, Bauer, Utah.

A process is covered for treating ores containing at least one of the metals of the silver-lead-copper group. It consists in subjecting the ores to the action of an alkaline thiosulphate to dissolve at least a portion of any of the three metals when present; precipitating as sulphide from the alkaline solution any of the metals which are in solution; separating the precipitated sulphide, also any natural sulphides in the ore and any mineral particles to which a precipitated sulphide adheres, from the gangue by means of the froth flotation process while regenerating the solvent by the action of the precipitant upon the ore solution.

Recent Technical Publications

Some Recent Geological Research

ASSIMILATION AND PETROGENESIS — SEPARATION OF ORES FROM MAGMAS. *By John Stansfield. Valley Publishing Company, Urbana, Ill. Pages 197, Plates 30, 1928. Price $3.50.*

THIS book deals largely with the record and interpretation of the results of a long series of experiments made with the object of furthering our knowledge concerning assimilation of sediments by magmas and the separation of metallic sulphides from magmas.

Ten igneous rocks, representing common types ranging from granite to peridotite, were each mixed in three different ratios with each of the pure common sedimentary materials, including kaolin, calcite, and quartz; and in addition with each of the following: magnetite, hematite, siderite, dolomite, magnesite, tremolite schist, bauxite, chromite, and graphite. Each charge was ground to pass 100-150 mesh, thoroughly mixed and heated in a graphite crucible at temperatures between 1,230 and 1,600 deg. C. in electric furnaces or a kiln. The melts were completed and cooled in 24 hours in the electric furnace, and in about seven days in the kiln.

The process of separation of sulphides from magmas was similarly studied by heating and cooling mixes of each of the ten types of igneous rock in a ratio of 3 to 1 with each of the sulphides, chalcocite, bornite, chalcopyrite, pyrite, pyrrhotite, nickeliferous pyrrhotite, galena, and sphalerite.

The cooled products in all tests were carefully studied under the microscope, and the quantity and optical properties of the crystalline material determined in so far as possible.

Mr. Stansfield's book is well cross-indexed and contains a large collection of excellent photomicrographs of the results of the experiments, including several showing flowage structures due to movements of gas bubbles, sulphide globules, and gas bubbles attached to sulphide globules.

An introductory chapter of 42 pages gives a good summary review of the literature dealing with the problems toward which the experiments were directed. This serves to give a general perspective.

A number of results which have been inferred to arise in nature from assimilation by magmas were more or less closely approximated in the experimental melts. Melilite-bearing rocks through assimilation of limestone, and cordierite-rich rocks through assimilation of kaolin, were formed, and many minerals not in the parent rock materials were found in the products.

The author takes a very moderate view of the possible extent of assimilation, suggesting (page 138) that "perhaps 10 or 15 per cent may be the limit of the amount of foreign rock matter which has been assimilated by natural magmas." He places considerable emphasis, however (page 53), on the fact that in these experimental melts "great lapses of time" have not been required to accomplish homogeneity, and that therefore very great stretches of time are not necessarily required for the accomplishment of assimilation and diffusion in magmatic reservoirs. The reviewer would question whether results obtained by melting "thoroughly mixed powders" are at all comparable to a magma assimilating blocks or mineral particles of country rock.

The author makes a number of statements certain to provoke discussion. Among such are:

On page 25: "My view is that anorthosites may possibly illustrate the completion of the process of assimilation of shale or its equivalent."

On page 27: "I consider that they (blocks of rock) will become melted and incorporated in the magma before they have sunk for a distance of one mile."

On page 57 he states that with many melts augite is the chief mineral to crystallize at 1,410 deg. C., and olivine when heated to 1,230 deg. C.; and from this it is inferred that augitite may be formed at higher temperatures than limburgite. The reviewer would note that this is the reverse of the relation found in the forsterite (olivine)-clinoenstatite (pyroxene) constitutional diagram. A discussion of the possible reasons for the difference might well have been given. A doubt is left in the reader's mind as to whether true equilibrium relations were obtained at 1,230 deg. C.

From a number of mixtures of igneous rock and bauxite or kaolin, heated to 1,410 deg. or higher, sillimanite ($Al_2O_3 \cdot SiO_2$) is reported (page 57) to have formed. The determination of this mineral as sillimanite is evidently based on the indices of refraction being > 1.660. As shown by Greig and Bowen[1], this is not a certain diagnostic criterion, for mullite ($3Al_2O_3 \cdot 2SiO_2$) with impurities, such as iron or titanium in solid solution, may have equally high indices and similar optical properties. A chemical analysis would be necessary to prove the presence of sillimanite in these products.

In the interpretation of the results of his experiments upon the separation of liquid sulphides from liquid silicates, the author presents a novel conception of the character of an early stage of the magma and offers a new suggestion as to the active force aiding the separation of sulphide from silicate. He writes (page 143):

"My conception of the state of the magma is that it is a colloidal emulsion of sulphide or oxide globules dispersed in silicate fluid."

And on page 181: "It is found that sinking under action of gravity is an important factor in the separation of metals, sulphides, or oxides from magmas, but in addition it is found that the metals, sulphides or oxides show a very definite tendency to collect at the lateral, lower, and sometimes upper margins of the melts. This is considered to result from differences of surface energy between metal, sulphide or oxide globules colloidally suspended in silicate melt, and the boundaries of the reservoir enclosing the melt. Differences of surface tension result in the collection of globules at or near the walls having lower surface tension values. . . . The action of gas bubbles in carrying upward metal, sulphide, or oxide globules may result in the accumulation of ores at the upper contact of an intrusive body, by the process of flotation."

The author presents unquestionable evidence that sulphides have migrated laterally, as well as downward, in his melts. His interpretations, however, are open to the criticism that he has failed to discuss exactly what may have happened in his crucibles during the heating process. Greig[2] found a similar lateral migration of globules in the case of two immiscible silicates, and explained it as follows:

"As the temperature of the charge rises some liquid is formed, drawing the grains together; the charge shrinks from the walls of the crucible. With increase of temperature the charge melts, shrinks further, but remains standing upright in the form of a cylinder, due to the great viscosity of the siliceous liquid. The more magnesian liquid (immiscible) collects and drains out or is squeezed out from the siliceous one."

A number of the author's interpretations lack accompanying critical discussion, but the book contains a body of valuable data for reference and will undoubtedly serve to stimulate fruitful discussion. A. F. BUDDINGTON.

WORLD MINERAL STATISTICS — The statistical summary of the mineral industry of the British Empire and foreign countries for 1925-1927, which is prepared and published by Imperial Institute, London, has just made its appearance. It gives figures showing the production, exports, and imports of 48 mineral products or classes of products in all countries of the world. It contains 375 pages and is priced at 8s. net. This and other bulletins of the Institute may be obtained in London at Adastral House, Kingsway, W.C.2, and in the United States at the British Library of Information, 4 East 45th St., New York City. Information obtainable conveniently in no other way is presented.

[1]Greig, J. W., and Bowen, N. L.: "The System $Al_2O_3 \cdot SiO_2$." *Journal and American Ceramic Society*, pp. 250-253, 1924.

[2]Greig, J. W.: "Immiscibility in Silicate Melts." *American Journal of Science*, Vol. 13, pp. 21-22, 1927.

NEWS OF THE WEEK

Summary

DEVELOPMENT of chrome ore deposits at Mashonaland, in Rhodesia, promises to make this district as important as the older Matabeleland area. Page 959.

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The House committee on the budget of the Department of the Interior has granted a small increase over the amount allotted by the Budget Director to the appropriation for the Geological Survey. Page 957.

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At the third meeting in New York devoted to copper within the last six weeks, W. C. Bennett, of Nichols Copper, addressed the Mining and Metallurgical Society of America. Page 958.

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A flood at the Morococha property of Cerro de Pasco Copper resulted in the death of between 50 and 60 men, according to Associated Press dispatches. Page 956.

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Development results in the southwestern part of the Sylvanite Gold mine, adjoining Wright-Hargreaves, in the Kirkland Lake district, have been favorable. Page 955.

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The new hoist installed at the Morning mine of Federal Mining & Smelting, in the Coeur d'Alene district, has been in successful operation for three weeks. Page 955.

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The new 40-ton furnace built by Acme Mining & Milling for its La Joya quicksilver mine, in California, has been started. Page 958.

* * *

Operations have been started at the new Verde Central concentrator at Jerome, Ariz. The plant handles 300 tons daily. Page 956.

* * *

The Mexican government has sent a commission to investigate conditions in Jalisco in the hope of preventing shutdowns. Page 959.

Mining Congress Elects Tally President

Operator's Problems and Conditions in the Industry Discussed at Annual Meeting in Washington

COAL has yielded to copper in the matter of presiding over the affairs of the American Mining Congress during the coming year. At the organization's thirty-first annual convention, held at the Mayflower Hotel, in Washington, on Dec. 5-8, Robert E. Tally, managing director of United Verde Copper, was elected president, succeeding J. G. Bradley, of the Elk River Coal & Lumber Company. The newly elected directors are listed elsewhere in this article. James F. Callbreath, the father of the Mining Congress and its guiding genius since it first was organized, will add another year to his long term of office as secretary.

The period of the convention coinciding this year with the opening week of Congress, the delegates and visitors found Washington alive and stirring. Fine weather added to their enjoyment of the program provided for their interest and entertainment. The list of registrants showed about 300 people present.

The Convention Opens

No happier way of opening a convention can be devised than that of tendering the delegates a complimentary luncheon. This expedient, adopted by the Mining Congress last year with marked success, was repeated this year with equally good results. It has the great advantage that everyone, or nearly everyone, is prompt. A gala atmosphere prevails, especially amid the attractive surroundings of the Mayflower. Such an opening is indeed a function which no one wants to miss. Care was taken not to mar the felicitous occasion with lengthy after-luncheon addresses. A half a dozen speakers, each limited to three minutes, supplied the program. J. G. Bradley, president of the congress, acted as toastmaster. He called successively upon A. G. Mackenzie, secretary of the organization's Utah Chapter; S. S. Tuthill, secretary of the American Zinc Institute; and G. Chester Brown, secretary of the California Metal and Mineral Producers' Association; and, showing no partiality, he introduced an equal number of prominent representatives of the coal industry.

Mr. Mackenzie, famous for his description last year of Utah's mineral wealth, presented a brief résumé of conditions in the mining industry of his state. The gross value of its metal output in 1928 would probably exceed that of 1927. The advance in the price of copper would largely, if not wholly, offset the less favorable conditions of the other metals. Efforts to obtain greater economy and efficiency were still being made, he said, in consequence of the continued high cost of services and supplies. Recently published statistics covering the mining industry of the state, including coal, showed that its payroll was one-third of the total shown on the payrolls of the state industrial commission; that the mineral tonnage was more than 80 per cent of the total railroad tonnage originating within the state; and that supplies purchased for company use totaled $50,000 a day.

World zinc conditions were surveyed

New Officers Elected by Mining Congress

President — Robert E. Tally, Clarkdale, Ariz., managing director, United Verde Copper Company.

First vice-president—William H. Lindsey, Nashville, Tenn., president, Napier Iron Works.

Second vice-president — Jesse F. McDonald, Leadville, Colo., president, Down Town Mines Corporation.

Third vice-president—S. L. Mather, Cleveland, vice-president, Cleveland-Cliffs Iron Company.

Secretary — James F. Callbreath, Jr.

Directors—For three years beginning 1929: J. T. Skelly, Wilmington, Del., Hercules Powder Company; Robert E. Tally; S. L. Mather; and Otis Mouser, Philadelphia, president, Stonega Coal & Coke Company. For two years beginning 1929: William H. Lindsey.

Executive Committee—Robert E. Tally; J. B. Warriner, Lansford, Pa., vice-president, Lehigh Coal & Navigation Company; and Otis Mouser.

briefly by Mr. Tuthill. Consumption of zinc today was the highest on record, he asserted, citing statistics that bore witness to his statement. Electrolytic zinc plants had increased in number, both abroad and at home, whereas there was no change in the number of retort smelting plants. In 1927, there were three electrolytic zinc plants in Europe. During 1928, three more were placed under construction and two were projected. These eight plants, using "by-product" ores, would ultimately have an annual capacity of between 80,000 and 90,000 tons. The world output of electrolytic zinc will soon exceed 20 per cent of the entire production of zinc. So-called new processes for making slab zinc remained practically *in statu quo*, said Mr. Tuthill. The principal change at home had been an increased production of electrolytic zinc through plant additions in Montana and a new plant now operating in Idaho. A third electrolytic zinc plant was being projected for East St. Louis. All of this meant a further shifting of the domestic sources of supply of zinc concentrates and of zinc metal. Exports of concentrates from the United States had been practically nothing in 1928, the speaker said. He concluded with a brief survey of the market for zinc products.

Conditions in California's mining industry were sketched by Mr. Brown. Operators had several problems. First, the state had the highest provision for workmen's compensation insurance, ($8.04 per $100 payroll, modified by an experience rating based on a period of five years) of any metal mining state. Second, high-grading conditions were especially bad. The local ore buyers license act was insufficient and a federal act was wanted. Third, the Tax Amendment No. 3 to the State Constitution required that the mining industry must have a bill providing for metal mine depletion adopted by the next Legislature. Fourth, labor was inefficient and the cost of supplies high. Finally, there was a lack of capital for developing prospects in California, owing to the rigid laws.

So far as the *E.&M.J.* reporter was concerned, the speakers had to talk in competition with certain disorderly but decorative parakeets that were near by in gilded cages. This is cited not so much to show the need for a sergeant-at-arms as to indicate the exotic atmosphere of the Palm Room of the Mayflower.

Aspects of International Mining

"International Mining" was the general topic of the first session, which was held on Wednesday afternoon. Mr. Bradley presided. J. W. Furness, chief of the Minerals Division of the Bureau of Foreign and Domestic Commerce, presented a paper full of significant facts on the topic "Some of the Outstanding Factors in the Flow of Minerals Into World Trade." The great sources of mineral supply were too few, he said, and too irregularly distributed, to give each nation its desired quota. No nation had a well-balanced supply of all minerals. Nations were therefore interdependent in regard to mineral supply, and in consequence international movement in trade in minerals was inevitable. There was a mineral trade balance between countries, he said, which could be changed only in minor ways by an effort of man. An understanding of this balance was necessary to any interpretation of broad economic relations. Moreover, the mineral trade balance based on unequal geographic distribution carried with it abundant

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sources of international friction. An understanding of this fact, said Mr. Furness, was the first step toward meeting problems in this vital field of international relations.

The United States was the world's largest consumer of mineral raw materials, Mr. Furness said, and in many cases the largest producer of many of the minerals. For certain of them it was entirely dependent upon foreign sources to meet its requirements; for others, in specific cases, as an importer, it was a vital factor in the world's market. Nevertheless, despite its large contribution to the world's production, it produced few minerals which were exported in quantities sufficient to affect the world's market appreciably. Mr. Furness' talk was illustrated with interesting charts.

Canadian Mining Flourishes

G. C. Bateman, secretary of the Ontario Mining Association, was on the afternoon's program. His paper, entitled "Canada Now and in the Future," summarized the remarkable and now well-known developments and events that have taken place in Canadian mining, particularly in Ontario. Taking camp by camp, he gave such an impressive account of occurrences that many a person in the audience doubtless lamented to himself, while listening, that he had not mortgaged the family homestead to invest in Ontario mines. His story of the recent happenings in the Sudbury nickel district was of particular interest. Mr. Bateman proved a capable spokesman for Canada's mining industry.

"The Mining Industry of Argentina" was the topic of the next speaker, H. Bentley Mackenzie, formerly Commercial Attaché at Buenos Aires. He cited facts to show that although prospects for the mining industry were good in Argentina, the actual development of the industry was still rather limited, with the exception of petroleum. Conditions with respect to taxation and laws were favorable. Oil had become an important factor in the country's wealth.

Mining conditions in South Africa were sketched by Perry J. Stevenson, American Trade Commissioner to South Africa. The importance of that country to American capital interested in foreign investments was growing, he said. American dollars had been going in on an increasing rate. With stable governments, sound legal systems, generally low taxation, and a sympathetic attitude toward American capital, especially when on a partnership basis, conditions appeared distinctly favorable, he thought.

Problems of Taxation

Taxation of minerals, a subject of fundamental importance in the activities of the American Mining Congress, was the subject of the Thursday morning meeting. The first paper was that of H. B. Fernald, of New York, on "Taxation of Income and Gains from Securities." Mr. Fernald endeavored to show how the present system has resulted from the meeting of some of the basic theories of taxation, often in head-on conflict as applied to this subject. In the course of his lengthy paper he said that the plans of the Treasury Department for determining the source of distributions for domestic corporations failed utterly to apply to the distributions from foreign corporations. Administrative difficulties, however, should not be made a ground for denying to stockholders rights to which they were entitled under the law as well as in equity. The owner of foreign securities should not be taxed on that which did not constitute real income to him. The government should not attempt to tax such distributions to the stockholder without giving him full opportunity to present evidence on the matter and without being ready to credit such evidence. This, Mr. Fernald said, he understood the department was now ready to do.

Following Mr. Fernald's thoughtful discussion, the Hon. E. C. Alvord, of the Treasury Department, spoke on the new income tax regulations. The interests of the taxpayer and the Treasury are not as divergent as is usually considered, he pointed out. There was no aim at a "hard-boiled" execution of the law, but rather an effort to carry out its provisions wisely and well. There was no doubt of the honesty as a whole of both the Treasury and the taxpayer in the preparation of a proper return.

Promptness of adjustment at present was especially emphasized by Mr. Alvord. The audit of current returns can now be completed several months before the running of the statute of limitations, which, under the new act, is two years. Most cases are now adjusted inside of twelve months. Litigation, however,

prevents prompt adjustment, especially where questions of law are concerned; questions of fact are not so difficult, though it must not be expected that they can be settled with mathematical accuracy.

Questions of tax liability should be settled at home with the assistance of representatives of the government tax bureau. Every effort is being made by the department to have courteous and capable men in the field for this work. Tax liability, however, cannot be compromised except in special cases, such as insolvency. The department is also attempting to promote certainty in the regulations, and to do away with annoying retroactive features.

Double Taxation Relief

Mitchell B. Carroll, the third speaker, had just returned from Geneva, where he was one of the representatives of the U. S. Department of Commerce. He discussed foreign mining taxes and double taxation relief, mimeographed copies of his address being available.

The establishment by American companies of mining enterprises abroad or the holding of shares or bonds issued by foreign mining companies frequently entails liability to foreign as well as domestic income taxes. Double taxation results. Certain relief against this cumulation of taxes is provided in the United States Revenue Act, but from a world viewpoint double taxation exists to a very discouraging extent.

Conventions intended to serve as models for states desiring to eliminate the double taxation of international trade and investments were adopted at a conference in Geneva, Oct. 22-31, 1928, composed of experts representing 27 of the important commercial countries. Three of these standard bilateral conventions preclude the levying of income taxes both in the country where the income originates and again in the country where the recipient resides. A fourth restricts multiple liability to death duties. The fifth and sixth conventions deal with mutual administration assistance in the assessment and judicial assistance in the collection of taxes.

The last scheduled speaker, McKinley W. Kriegh, chief of the tax division of the American Mining Congress, was interrupted early in his address to permit a talk by Secretary Davis of the Department of Labor. Mr. Davis discussed overproduction throughout the mining industry, with resulting disastrous competition, especially in coal. He then reiterated his opinions on the subject of wages, emphasizing that the first thought of employers should be the wages of their men. The only prosperous industries, he maintained, are those that pay good or high wages. Mechanization of industry and its attendent problems were also dwelt on, the Secretary citing one metal-mining company that had reduced the number of its employees from 650 to 280 without reducing output and contemplated a further reduction in personnel to 100. The 100, said Mr. Davis, should have their share of the wages saved, thus increasing their consumptive capacity, to the end that productive industry will not be affected adversely. In 1921 there were reported 166,000 men employed in metal mining, producing 120,000,000 tons of ore; in 1927, 120,000 men produced 150,000,000 tons of ore.

Resuming his task, Mr. Kreigh discussed the progress of government studies of mine depletion allowances and the practicability of a percentage of income basis for determining depletion.

Congress, said Mr. Kriegh, will in the near future consider an amendment to the law providing for the determination of depletion allowances in case of mines as a fixed percentage of income. Mr. Kriegh stated that the mining industry "has been singled out for special forms of taxation, and has been discriminated against by taxation authorities, generally."

Mechanization and Human Progress

Mechanization of operations has such important significance in the coal-mining industry that the session on Friday morning was devoted to a discussion of various aspects of the topic. Two papers were presented. One, on "Mechanization and Human Progress," by Colonel M. C. Rorty, vice-president of the International Telephone & Telegraph Corporation, dealt with the three objections occasionally raised against the mechanization of industry—namely, that it caused unemployment; that it reduced workers to a condition of nervous strain; and finally that it tended to bring about the disappearance of the skilled artisan in industry. Mr. Rorty effectively disposed of these contentions, and in their place depicted the benefits that come from mechanization. The other paper, "What Mechanization Means to the Mine Operator," was presented by J. B. Pauley, of the Miami Coal Company. Opportunity for further discussion of the topic was afforded at an extension of the session in the afternoon.

Copper—Its Future

H. DeWitt Smith, assistant managing director of the United Verde Copper Company, presided at the session on Friday. Before introducing C. F. Kelly, president of Anaconda, who was on the program, he reviewed the copper situation briefly, giving salient facts. Refined stocks were at a low and dangerous point, he said, and this reduction had been effected in the face of a production greater than ever before. Nevertheless, prices were not far removed from the war-time level, despite the great increase in costs of labor and supplies. Speaking of overproduction in other industries, he said, the federal government might well co-operate with these industries along broad lines in an effort to help them share in the general prosperity. He then called upon Mr. Kelly.

The copper industry had just recovered from having a billion pounds of copper left on its hands at the time of the armistice, said Mr. Kelly. In taking steps within the industry to correct conditions, the operators had succeeded in keeping within the law. Under the Webb-Pomerene Act they had united their efforts to sell abroad, and, more recently, had corrected the effect of the London Standard copper market—all of this with the approval of the government.

It was up to every man in the copper industry, moreover, to look at his own figures of production and decide what course of action he should follow. He had no apprehension as to the future, Mr. Kelly said. The industry's principal concern should be as to how it was going to meet the demands that would be made upon it. Referring to the Oil Conservation Board, he said that it had done remarkable work. The petroleum industry had been more demoralized than the copper industry, and the latter should profit by its example. As for the future of copper, he knew of no way to judge it, save by some formula based on past experience. The present rate of production could not be expected to continue indefinitely, he said.

War-Mineral Strategy

Ways of providing against a war-time scarcity of minerals having strategic importance in the prosecution of a war were discussed at this session by Colonel C. B. Robbins, Assistant Secretary of War. Four steps might be taken where the domestic supply was limited or lacking. Strict economy might be exercised and unnecessary uses curtailed or abolished; substitutes for these minerals might be developed; domestic production might be augmented; or, fourth, a stock might be accumulated in time of peace and held in reserve. The search for substitutes for minerals now on the strategic list was already under way, said Colonel Robbins. He cited instances that showed how much might be achieved by a thorough study along this line. Comparative costs of production of two materials determined the selection made for commercial use, but were of no great moment from the military viewpoint in time of war. As for the fourth step, a definite policy as to accumulating a reserve could not yet be recommended, inasmuch as the possibilities of substitution had not been investigated fully.

The Iron Miner's Problems

S. L. Mather, vice-president of the Cleveland-Cliffs Iron Company, after sketching the development of iron mining in the Lake Superior region, spoke of the problem confronting the operator there because of heavy taxation. Taxes were now four times as heavy as they were twenty years ago. Legislators could not realize, evidently, that the laws were working such hardships. Freer discussion of the subject was desirable and less individual action.

The Banquet

On Friday evening, the annual banquet of the Mining Congress was held. Several hundred guests were present. Philip P. Campbell, formerly Congress-

man from Kansas, was toastmaster. Rev. James Shera Montgomery, Chaplain of the House of Representatives, pronounced the invocation. The orator of the evening was ex-Senator A. O. Stanley, of Kentucky, who delivered a long speech. Entertainment was given by the National Broadcasting Company.

Agriculture and Mining Related

The interrelationship between agriculture and mining was the theme of Scott Leavitt, of Montana, at the closing session on Saturday. Four per cent of the total amount of steel produced (in 1926) went into farm machinery, another 4 per cent into containers, and additional tonnage into other equipment used on farms. Moreover, huge quantities of oil and gasoline also were used in agriculture. These and other facts, the speaker thought, demonstrated that the prosperity of workers engaged in mining was essential to those in agriculture.

The American Standards Association

An important paper dealing with the reorganization of the American Engineering Standards Committee was read at this session by William J. Serrill. A new constitution had been provided, as well as a new name, this being the "American Standards Association." Activities of the new organization are to be supervised by a board of directors, not to exceed twelve in number, under whom is the so-called Standards Council, which will have technical direction of the work. The prospects for national standardization were never so bright as at the present time, said Mr. Serrill, who is president of the association. A sum of $150,000 per annum would be needed for the work.

The Congress Goes on Record

Resolutions adopted by the Mining Congress at the closing session on Saturday called for revision of national tax laws to relieve the mining industry of burdensome taxes, the exemption of income from gold mines due to declining gold production caused by increased costs of operation, and the provision of increased funds for developing new mineral resources under government guidance. The Mining Congress was also authorized to create a committee to investigate and assemble data concerning geophysical prospecting methods, with a view to recommending any possible changes in federal mining laws that would facilitate prospecting by these methods. Indorsement was given to the principles involved in a federal "high-grade" act proposed for the purpose of protecting operators of gold and other mines. A bill to this effect, it is hoped, will shortly be introduced in Congress. The organization went on record as favoring the restoration to mineral entry of withdrawn public lands bearing minerals in the Angeles and other national forests in California. Increased appropriations were urged for federal and state bureaus of mines and geological surveys and other governmental agencies that serve in the discovery and development of new mineral resources. Opposition to government entry into business was expressed, the resolution stating that "the government shall not enter any gainful business or pursuit which places the government in competition with private enterprise."

Organization of state and local taxpayers' associations and the formation of committees to pass on bond issues and other public projects were recommended, with a view of curbing the rising costs of state and local government, as well as unreasonable taxation.

Declaring that "one of the chief complaints of the mining industry has been the harsh incidents of the national taxation laws to the business of mining," the organization commended Congressional committees and Treasury officials for efforts to reach an equitable solution of the mine tax situation. Delays in affording equitable relief were deplored, and recommendation was made that prompt legislative action be taken by amendment to the National Tax Law to relieve the mining industry of present burdensome mining taxes. In another resolution Congress was also asked to exempt income derived from gold mining from the federal income tax. Tariff protection sufficient to permit the greatest possible development of the mineral industries of the country was also advocated.

Build Plant to Obtain Aluminum in Virginia

INTERNATIONAL Silica Corporation is constructing a plant and installing the necessary machinery for the development of large aluminum deposits at Edgewood, 2 miles east of Salem, Va. This corporation controls the McAdoo patents and Johnson process for extracting aluminum from shale found in that locality. These processes, according to the inventor, will produce aluminum oxide, from which metallic aluminum is made, at a cost said to be considerably lower than the average for manufacture of aluminum from bauxite. Assisted by Dr. H. I. Johnson, professor of chemistry at Roanoke College, as consulting chemist, McAdoo has experimented for the last three years at Edgewood.

Spur Railroad Being Built to Cripple Creek Mine

A spur track is being built by the Midland Terminal railroad to the Block Eight mine, in the Cripple Creek district of Colorado. This property has been leased by Cresson Consolidated Gold and is now being developed under the supervision of Wilbur Steele. A 50-hp. electric hoist has been installed. A large amount of low-grade gold ore is known to exist on the ground.

Anaconda, Braden Copper and Guggenheims Succor Chilean Quake Victims

ANACONDA subscribed 400,000 pesos and Guggenheim Brothers and the Braden Copper Company each contributed 200,000 pesos to the Chilean government relief fund to care for the victims of the recent earthquake in Chile. The Chilean Electric Company also made a large contribution. On Dec. 6 the fund totaled 1,317,000 pesos (about $158,000), according to a special cable dispatch to the New York *Herald Tribune*. In addition huge supplies of medicine, food, and clothing have been donated.

The director of the Chilean El Salto Observatory, Bustos Naverette, has expressed the opinion that further serious earth shocks are unlikely to occur for some time.

Sylvanite Obtaining Good Results in Development

SYLVANITE Gold, in the Kirkland Lake district of northern Ontario, is obtaining better results in the development of the southwestern section of its mine than have been secured elsewhere. New ore is being opened up north of the Wright-Hargreaves boundary, and is believed to be a continuation of the No. 1 deposit of that mine. Work in this section was started on the 1,000 level, but subsequently a raise was driven to about the 859 level. Drifting for a distance of about 300 ft. has been done on this horizon in ore of good grade, carrying telluride and free gold. A new hoist is being installed, and the owners of the property expect that it will be operating by the first of the year. The new equipment will permit four times the present production from the mine. The mill is treating about 200 tons daily, and is averaging about $11 a ton.

New Morning Hoist Operating

The new electric Nordberg hoist at the Morning mine of Federal Mining & Smelting, in the Coeur d'Alene district, has been in operation for three weeks. It will permit operation at the depth of 3,500 ft. below the operating tunnel level, or about 4,500 ft. below the surface, and will lift four tons at a speed of 1,300 ft. per minute. Installation of the new machine, which took two months, was accomplished without interfering with operations at the mine, and the transfer from the old to the new hoist was accomplished with the loss of less than one shift.

Peerless Obtains Power

An electric power line has been completed to the Peerless mine, near Wallace, in the Cœur d'Alene district, by the Washington Water Power Company. Excavations for a compressor building have been started.

Verde Central Starts Operating New Mill

OPERATION of the new 300-ton concentrator built by Verde Central Mines, Inc., at Jerome, Ariz., was started on Dec. 1st. The plant is producing copper concentrates for shipment to the United Verde Extension smelter at Clemenceau. Earl M. Smith is the mill foreman. Ore handled is chalcopyrite and pyrite in quartz gangue, and averages about 4 per cent copper.

According to Robert Dickson, manager of the company, which is a subsidiary of Calumet & Arizona, the mill will use a 12x24 in. Blake jaw crusher, followed by a pair of 54x24 in. rolls for coarse crushing. Fine grinding will be done in two 8x36 in. Hardinge ball mills, inclosed in circuit with a 6x26 ft. Dorr duplex classifier. McIntosh flotation machines will be used. Concentrates will be thickened in a 24x9 ft. Dorr thickener and filtered in an American filter. Concentrates will be transported to Jerome by truck and then by railroad to the smelter.

Shattuck Denn Makes Strike on Ophir Claim

THE new ore strike in the Denn mine of Shattuck Denn Corporation at Bisbee, Ariz., is reported to average 6 per cent copper. The ore was found on the 1,800 level in the Ophir claim. Calumet & Arizona's drift on the 2,000 level passed through 40 ft. of 8 per cent ore at a distance of about 40 ft. from a corner of the Ophir claim. This ore dips toward Denn ground, and is believed to be part of the same oreshoot as the new Denn find.

Because of limited hoisting facilities, Shattuck Denn development work on the new orebody has been delayed. The company now has a new steel headframe erected and is installing a new electric hoist. Its main shaft has been sunk to the 2,200 level, but about 400 ft. of drifting will have to be done on that level and the 2,100, so it will be some months before the new orebody will be mined. The company has made an agreement with Calumet & Arizona whereby the latter company will drain the Denn property through its Junction shaft, which is to be connected with the Denn mine on the 2,000 and 2,200 levels. The agreement also covers ventilation.

Duval Texas Sulphur Making Large Production

THAT the new sulphur deposit opened near San Diego, Tex., by the Duval Texas Sulphur Company will quickly become an important factor in the sulphur production of Texas is indicated by the success of the company in mining from two wells. Production is now approximately 240 tons of sulphur a day, and this may be increased as additional wells are sunk into the deposit, which, according to test holes, covers the greater part of the 2,000 acres which the company has leased for sulphur development purposes. The deposit is in the lower Gulf coast region and is more than 100 miles west and south of the deposits in the vicinity of Houston.

The Duval company plans to begin exporting through the port of Corpus Christi as soon as the surface supply is sufficient to justify construction of a warehouse and other port facilities. The new port is only 65 miles from the mine.

J. W. Cain, of Houston, is president of the company; A. H. Smith, vice-president, and D. B. Cogswell, secretary-treasurer. The ownership of the sulphur property was recently reported to have passed into the hands of the Moody-Seagraves natural gas interests. The supply of gas for fuel purposes is abundant and near by.

Atlas Cement to Drill for High-Grade Limestone

The Atlas Cement Company has purchased 500 acres of land in and surrounding the old town of Volcano in Amador County, Calif., and is expected to start development of the limestone deposit underlying the townsite about the first of the year. Options have also been taken for a right-of-way for a railroad from Ione through Sutter Creek to Volcano. Drilling has proven the existence of a very large body of high-grade limestone.

Sillimanite Corporation Installs Power Plant

Sillimanite Corporation, operating a property in the White Mountains northeast of Bishop, Inyo County, Calif., has installed a 220-hp. hydro-electric plant and a 5-mile transmission line to supply power for its operations. A head of 880 ft. is utilized in a 12-in. pipe line, 10,000 ft. in length.

Flood in Campana Mine Drowns Workers

Many workers were drowned on Dec. 6 in the galleries of the Campana mine, near Morococha, Peru, according to an Associated Press dispatch to the New York press, when the bottom dropped out of the San Francisco Pond, on the mining property, letting water into the shaft. The Campana is owned by Cerro de Pasco. An American mining engineer named McCormack is reported to be among the victims of the disaster, who are recorded as numbering between 30 and 60. Several mines in the vicinity are connected by galleries, in which rescue work was progressing when the news of the accident was cabled.

Shafthouse Completed at Quincy No. 8 Shaft

AT QUINCY MINING, in the Michigan copper district, the shafthouse moved from No. 7 to No. 8 shaft has been completed. It is of steel and concrete construction and fireproof. Sinking from below the 75 level will be started at once. This shaft will be lowered 1,200 ft. and levels driven every 100 ft. Sinking in No. 6 has reached a point below where the 89 level will be established. After cutting the station, crosscutting to the Pewabic bed and drifting will be started.

Repair work in No. 2 is progressing satisfactorily, but this unit will not go into commission until after the first of the year. Sinking will be pushed vigorously in all three shafts, and a considerable tonnage should be obtained from the drifts. Quincy will not come into full production, however, until more of its openings are extended and stoping from the boundaries back to the shafts is started.

Phelps Dodge Installing Pumps at Warren Shaft

The pump station on the bottom level of the new Warren shaft of the Copper Queen Branch, Phelps Dodge Corporation, at Bisbee, Ariz., has been completed and installation of two 1,000-gal. pumps is well under way. The Warren shaft is now bottomed at 2,147 ft., and no further sinking is contemplated until required by future developments. Drifts are being driven on the 900, 1,800, and bottom levels. The Warren shaft was sunk by the E. J. Longyear Company, under contract, and work was begun in January, 1927. It was completed last summer, eighteen months after starting.

Report Option Taken on Arizona Quicksilver Mine

George Kingdon, general manager of the United Verde Extension Mining Company, is reported to have taken an option on a majority of the stock of the Quicksilver Corporation of America, whose property is located in Dreamy Draw, a few miles northeast of Phoenix, Ariz. This company has recently installed a Diesel engine, a generator, and a 200-cu.ft. capacity compressor. A 150-ft. shaft has been sunk, and the last 20 ft. is reported to have averaged 60 lb. of quicksilver per ton.

Goldroad Strikes New Vein

A crosscut on the 300 level of the Goldroad mine, in the Kingman district of Arizona, struck a new quartz vein, 5 ft. wide, which the management believes to be a continuation of the old Glory Hole vein. Development of the main orebody, which is being mined on the 300 level, will be continued at greater depth.

Surface workings of the old Horn Silver mine, in Beaver County, Utah

Tintic Lead Takes Over Horn Silver Mine

THE Horn Silver mine, situated in the San Francisco district, Beaver County, Utah, has been acquired by the Tintic Lead Company, headed by Lorin N. Morrison, president, of Salt Lake City. Operations have been resumed on several levels for the purpose of locating the faulted segment of the Horn Silver orebody, which produced in four acres of ground to the 900 level $54,000,000 since the mine was discovered in 1878. A. E. Kipps, consulting geologist and mine manager, is in charge of operations. The property is fully equipped with buildings, has a 150-ton mill, a 1,600-ft. three-compartment shaft, double deck cages, electrically driven, a ten-drill Sullivan compressor, hoist, motors, and transformers.

Horn Silver's orebody lay along a trachyte-limestone contact, with the sedimentary as a footwall and the volcanic rock as a hanging wall. The ore occurred as a replacement of the limestone in a series of orebodies several hundred feet long and a hundred feet wide.

Aconda Will Explore New Kamiskotia Property

OFFICIAL announcement has been made that Aconda Mines will start a diamond-drill campaign on the Ross property, in the Kamiskotia field of northern Ontario. Three well-defined breaks, 12, 16, and 20 ft. wide, have been uncovered, with masses of pyrrhotite carrying copper mineralization. The breaks are parallel and about 16 and 40 ft. apart. Holes will be put down at intervals of 200 ft. along the break.

The company will also undertake diamond drilling on its property in Duparquet Township, in the Rouyn area of Quebec. Several test pits have been put down over a distance of 2,000 ft., and channel assays over varying widths are stated to have shown consistent results, averaging about $8 a ton.

Abana Resumes Mine Work

Charles Spearman, consulting engineer of Abana Mines, in the Rouyn district, Quebec, announces resumption of underground operations at the property. Crosscutting has been started on the No. 2 orebody at No. 3 crosscut, 300 ft. east of the diabase dike, for the purpose of determining width and length. The ore contains copper and zinc. The new Diesel engine, used for the new Ingersoll-Rand compressor, and the electric hoist are working smoothly.

Ardsley Butte Crosscutting

Ardsley Butte Mining is crosscutting south of the shaft on the No. 5 level to tap the main Highland vein at its property in the Butte district of Montana. A fault has been encountered which has delayed the work. In the meanwhile the company continues to ship ore from the upper levels. The last three cars sent have assayed between 67 and 74 oz. of silver to the ton. This is the highest-grade ore ever shipped from the property.

Lopez Mining Plans Development

The Lopez Mining Company, operating 4 miles north of Plymouth, Calif., has encountered a good pay shoot on the 380 level and is drifting south. The property consists of 160 acres. Peter Lopez is president, Judge McKewen, secretary-treasurer, and Charles Blake, superintendent. Development is being financed by the sale of 160,000 shares of stock under permit of the California Corporation Commission.

House Committee Increases Geological Survey Budget

By Paul Wooton
Special Washington Correspondent

IN THE hearing before the House committee on the Interior Department appropriation bill, the chairman of the subcommittee in charge, Representative Cramton of Michigan, emphasized the significance of the growing annual production of the mines of the country and agreed that this must mean the assumption of added responsibilities on the part of the federal bureaus dealing with that industry. He read to the committee the following extract from a recent address made by Dr. George Otis Smith:

"Back in 1890 the Sherman Law was passed; since then the population of the United States has about doubled. Since then, too, the annual product of the mines of this country has increased better than eightfold—from six hundred and fifty millions to five and one-half billions of dollars. Since then the four largest branches of the mineral industry, which supply the iron and copper, the bituminous coal and petroleum, the bone and sinew and energy of all other American industries, have increased their annual output nearly tenfold as to value and sixfold as to quantity."

In commenting further on the subject Dr. Smith made this statement to the committee:

"I believe it is a fairly good measure of our added responsibilities, because this task of furnishing raw materials, or mineral raw materials, which is laid upon the mineral industry, involves necessarily some new sources of the essential minerals. As I have stated to the committee in other years, we have found in this country the easily found and easily exploited ore deposits, and now search has to be made by refined methods. It is to that class of work that we are giving special attention, and I think that is appreciated in the mining states of the West. Colorado presents a case in point—that is, where a state has come to us with a generous co-operative fund—and has asked our geologists to assist them in finding ore. This does not involve a philosophical discussion of the genesis of ores so much as applying what has been done and learned in the past to the special task of seeing whether there is more ore in this district, or whether there is another district on the other side of the range from where they may have already mined ore. I think that type of work touches right upon the present demand for a revival of mining in the Western states, and those, of course, are largely the public land states."

The committee approved $2,040,800 for the Survey, which is an increase of $25,500 above the budget estimate. An increase of $30,000 for Geological Survey printing also was allowed in the appropriation for the office of the secretary.

M. & M. Society Hears Bennett on Copper at December Meeting

By Homar L. Johnson
Assistant Editor

THE copper industry and its various phases continue of paramount interest to New York engineers, judging by the number of recent technical meetings devoted to the subject. The third important meeting in six weeks of the two leading technical organizations on the general subject of copper was that of the Mining and Metallurgical Society, at the Harvard Club on Wednesday evening, Dec. 5, when W. C. Bennett, of the Nichols Copper Company, spoke on "The Position of Copper."

Mr. Bennett outlined briefly the routine operations of the copper sales agencies involved in the marketing of this commodity. He traced the decline in stocks of refined copper from approximately 300,000 tons at the end of 1919 to the low point of 45,648 tons on Nov. 1, 1928, and explained the effect of this change on the general condition of the market. The importance of the various statistical organizations developed since the war in yielding self-knowledge to the industry, and in improving marketing practice, was mentioned. Other points which Mr. Bennett emphasized were: the need for increased statistical knowledge of conditions at fabricators' and consumers' plants; education of these buyers to the advisability of accepting the return to larger stocks of copper at refineries as excellent insurance of their own immediately impending position rather than to use them as a "club" with which to force prices down; the present tendency of overemphasizing per-pound copper-production costs that, in some instances at least, were undoubtedly misleading and served to place the industry in an unfavorable light in the eyes of the general public, and the desirability of stabilizing the industry by giving due regard to the fluctuations of trade in the world.

The conservative viewpoint held by Mr. Bennett met with the approval of many of the members present, as was shown by the frank, animated and extended discussion which followed. W. R. Ingalls brought out the difference between visible and invisible stocks of copper, and stated that during periods of rising prices such as recently prevailed there is always a tendency for the statistics to appear to overstate the tonnage going into consumption, because fabricators were buying further in advance of their expected requirements than was customary. He recounted statistical difficulties experienced in distinguishing between salvaged junk copper, and circulating or process scrap copper, pointing out that his experience indicated the true ratio of junk to process scrap to be about 1 to 4. The statistics prepared by the Department of Commerce make no distinction between these two types.

In his discussion, Mr. Ingalls stated also that present refinery capacity was approximately 10 per cent greater than the current rate of production and that additional refinery capacity was in process of construction in Belgium and in Germany as well as in the southwestern United States. That it would be more logical to compare the statistical position of copper in 1928 with that of 1926, rather than with that of 1927, because of general economic conditions prevailing in that year, was stressed by Mr. Ingalls.

H. DeWitt Smith presented a statistical comparison of non-ferrous metal consumption which indicated that in the last 30 years the relative increase in consumption of copper and zinc had been nearly the same, whereas lead consumption had increased only half as much in proportion. He also drew a favorable conclusion from current statistics, which he interpreted as minimizing the possibility of any extensive competition between copper and aluminum at current price levels, because the increase in the consumption of copper in 1928 over that in 1927 appeared likely to exceed the total production of aluminum in 1925.

In connection with consumption, W. J. Nolle, of *Daily Metal Trade*, responding to a request for comment from a nontechnical viewpoint, mentioned the tremendous increase in the tonnage of copper sheets going into building and construction work and observed that the recent improvement of conditions in the copper industry appeared closely connected with the high rate of building activity and the tendency toward a more general use of copper in the building trade.

In response to a request for data on South American copper, W. J. Hamilton stated that the only property he was in position to discuss—Cerro de Pasco—was now producing at the rate of 50,000 tons per annum and that there was little probability of this rate being changed in the near future. Lucius Mayer referred to A. B. Parsons' article on "The Outlook for Copper" in *E. & M. J.* of Aug. 11, that contained an estimate of productive capacity of existing plants of approximately 2,100,000 tons per year, which, assuming a normal annual increase in consumption based on past records, would not be required until 1931. That current production had been stepped up so rapidly as to almost fulfill the prediction for 1931 by the rate in effect in the last part of 1928 might be taken as evidence of an abnormal increase in consumption at present which possibly might not be borne out in 1929 and 1930.

A. B. Parsons pointed out that current rate of production was 25 per cent higher than that of 1927 and hazarded an opinion that the copper industry might find stocks of refined copper building up more rapidly than was desirable if the present high rate of production were to be continued throughout the coming year.

G. Temple Bridgeman, who presided at the meeting in the absence of Clinton Crane, president of the Mining and Metallurgical Society, brought the meeting to a close by expressing his hopes that an equally enlightening dissertation on the subject of copper might be entertained a year hence with the industry then as greatly improved over conditions in 1928 as it was in 1928 over conditions in 1927, despite the general line of advice—for the industry to "keep its feet on the ground"—featured at this meeting.

Furnace at La Joya Mine Now in Operation

H. W. GOULD & Company reports the completion of the Acme Mines & Mill, Inc., quicksilver furnace at the La Joya mine, Napa County, Calif. Actual furnace operations began on Nov. 26, and the plant is now treating 40 tons of ore per day and making a satisfactory extraction.

The plant consists of a 3x40-ft. Gould Improved rotary furnace and condensing system with all modern equipment for treating 40 tons of ore daily. All the machinery is electrically driven, power being generated at the mine. The entire furnace requires only four men per 24 hours. The mine has been developed extensively during 1928 and is said to have sufficient ore to keep the plant in operation for some time.

Oil Companies Mining Their Own Fuller's Earth

FULLER'S EARTH is in such demand for refining oil that large plants for mining the product have been established near Midland, Tex. The Texas Company owns its own deposits of fuller's earth, and it recently installed extensive equipment for handling the output of its mines. Steam shovels are used for loading the fuller's earth upon cars, which haul it to large drying sheds, thence to the company's several oil refineries. The Crown Central Petroleum Company also has a large fuller's earth plant in operation near here. In addition to these two oil companies which own their own plants and deposits of the refining clay, other companies buy enormous quantities from private owners and operators of deposits here for use in their refineries. Several leases of deposits have been made by oil companies which plan to install their own equipment for mining the product.

Johannesburg Letter

By Owen Letcher
Special Correspondent

Mashonaland Chrome Areas Assume More Importance in Rhodesian Industry

Johannesburg, Nov. 6, 1928.—During the last few months, several large American corporations have evinced interest in Rhodesian chrome and have sent engineers to inspect the chrome fields. These engineers are very much impressed by the large tonnage of ore available, the favorable economic conditions existant, and the comparatively high chromic acid content of the beds. Hitherto most chrome ore exported from Rhodesia has come from Matabeleland. Recently, however, the Mashonaland deposits, which are not so massive as those near Selukwe, Matabeleland, but are higher grade, have been increasing their output.

THE best known of the Mashonaland chrome areas are "Peake's Chrome," "Lone Cow," and "Sheila's Luck." The last two have been acquired by Rhodesia Asbestos & Chrome Syndicate, Ltd., which, up to the recent merger with the Davis group, controlled 2,716 claims. This has been increased by buying 20 miles of ground from Messrs. Macauley and Larter. Great Southern Rhodesia Chrome, controlled by Messrs. Mann, Little & Company, of Johannesburg, has increased its holding to 148 blocks. These chrome blocks are all situated on both sides of the Great Dike and have recently been reported on by I. J. A. Diamond, who states that the general strike of the chrome seams is north-northeast. There are at least four distinct chrome seams on either side of the dike. They vary from microscopic size to a foot or more in thickness. The company's principal holding of 95 blocks is situated west of the dike, about 13 miles distant from Banket station. From work done to a depth of 100 ft. it would appear the seams show a tendency to increase in thickness with depth. On the Morri block 52 per cent and on the Early Bird block 53 per cent chrome oxide content has been obtained by sampling, and the average for 74 samples from the entire section was about 50 per cent. The most important feature of the occurrence is that it varies very little in grade at any point in the 10 miles between the Morri block, at the extreme south, and the Moss 8 block, at the north.

The ore is transported to Banket station for shipment at a cost of 8s. 6d. per long ton, and total cost is estimated at 74s. 6d., landed in Europe. Extension of the railroad to the site of operations will reduce costs and may permit mining below 100 ft., the present economical limit in depth. Mr. Diamond estimates available tonnage on the main section of the holdings at 660,000 tons to the 100 level. In other sections the tonnage available increases this to more than 1,000,000 tons. Mr. Diamond believes no danger exists of overproduction of Rhodesian high-grade chrome within the next few years.

NEW Primrose Gold, one of the largest producers on the Rand in its day, is about to suspend operations. Up to the end of 1927, the company had milled 7,806,524 tons of ore, yielding 2,339,847 oz. of gold. At the end of 1922, ore reserves were practically exhausted, being put at 25,000 tons. By reclaiming over a wide area, the company was able to continue mining until June of this year, when the mine was closed and the work confined to cleaning up the reduction plant. The Mynpachten claims have been sold to Witwatersrand Gold and 37 claims have been disposed of to a leasing syndicate. The remaining claims—117 in all—will be allowed to lapse.

Crushing began at the property in 1888, with a 20-stamp mill. From time to time the capacity of the plant was increased, until it consisted of 160 stamps and two tube mills, with cyanide works and accumulated slimes treatment plant. The company has paid £3,057,519 in dividends—more than ten times its capitalization. At present the company has cash assets of £50,900. A notice of stockholders' meetings on Nov. 29 and Dec. 21 has been issued. The question of placing the company in voluntary liquidation will be considered.

St. Louis Smelting Buys Mine Near Fredericktown, Mo.

St. Louis Smelting & Refining, a subsidiary of National Lead, has purchased the Schulte Mining Company, of Fredericktown, Mo. The Schulte company owns 775 acres of valuable mineral lands, 3 miles south of Fredericktown. A concentration and reduction plant will be erected in the spring and power lines will be installed.

Old California Tailings Dumps Are Reworked

A drag-line excavator is being used to move gravel at Deer Creek, Nevada County, Calif., with very satisfactory results. Tailings from the old Champion, Providence, and Home mines which deposited in the creek bed are being washed. In addition to fine gold, good-sized nuggets are also recovered.

California, There He Goes

Congressman Harry L. Englebright of California, has departed for Washington intent upon the passage of several measures that he has proposed for the benefit of the mining industry. These include the elimination of the income tax upon gold mining, increased appropriation for the U. S. Bureau of Mines and Geological Survey, and revision of débris regulations.

Mexico City Letter

By W. L. Vail
Special Correspondent

Government Commission to Investigate Conditions in State of Jalisco

Mexico City, Dec. 3, 1928.—The Mexican government is sending a commission to the State of Jalisco to investigate mining conditions in that state, with the particular object of preventing the suspension of the larger mines, with the consequent unemployment entailed. The most recent requests for permission to suspend operations in this state came from the Amparo and Piedra Bola properties. A suggestion has been made that federal and local taxes be radically reduced. Whether such a reduction, if effected, would be sufficient to cover the alleged deficits remains to be seen. Similar action was taken with a number of properties in Guanajuato recently, and the mines affected are still operating.

THE Eden mines, in Zacatecas, have recently been purchased by El Potosi, the Howe Sound subsidiary in Mexico, and several adjacent properties have been denounced. It is understood that the same company, which has acquired the sampling works and chemical laboratories of Gualterio C. Palmer, in Zacatecas City, is negotiating for the purchase of other mines in the district. J. J. Clausen, who had been with the company at Santa Eulalia, Chihuahua, is superintendent of Zacatecas unit.

A company formed by American interests has recently been organized to acquire several properties in the old mining camp of Zimapan, Hidalgo, about 130 kilometers northwest of Pachuca. The principal properties are known as the Guadalupe and Balcones groups. Tunnels will be driven for the purpose of mining known low-grade ore reserves and also for exploration. Chlorination plants will be constructed. The ore, after treatment by chlorination, will be leached by hyposulphite, a process that has been successfully used in other parts of Mexico. In addition, about 1,000,000 tons of slag which can be profitably treated with modern processes is estimated to be on the ground.

No changes of importance have been made in the mining section of the Department of Commerce, Industry, and Labor under the new administration which has just taken office. Dr. Puig Casauranc continues as secretary of the department and has asked all the heads of the sections dealing with mining to remain. The new labor law is still under discussion, and, if accepted, it will probably not go into effect before March or April. Latest reports are that the government is willing to withdraw some of the more objectional features, from the employers' viewpoint, in the belief that they are not practicable.

MARKET AND FINANCIAL NEWS

Copper Group Leads in Trend of Profits for 1928

PROFITS of general business corporations for the first nine months of this year are compared in a statistical analysis published in a recent issue of "The National Bank of Commerce Monthly." The accompanying table summarizes the changes in the third quarter and the nine months' profits of those industries where representation is large enough to be of significance.

Group	Number of Companies	Per Cent Change 1928 Over 1927 First 9 Months	Per Cent Change 1928 Over 1927 Third Quarter
Copper	8	+68	+117
Motor equipment	18	+52	+162
Petroleum	27	+45	+126
Retail chain stores	6	+25	+ 21
Motor	11	+24	+ 25
Chemical	8	+11	+ 12
Machinery and tools	10	+11	+ 70
Iron and steel	18	+ 8	+ 51
Food products	23	+ 5	+ 7
Building materials	8	+ 1	+ 15

The following groups showed decreases in earnings for the first nine months of 1928 as compared with the first nine months of 1927:

Group	Number of Companies	Per Cent Change 1928 Over 1927 First 9 Months	Per Cent Change 1928 Over 1927 Third Quarter
Tobacco (cigar manufacturers)	5	— 1	—10
Railway equipment	5	—35	—18
Bituminous coal	4	—39	— 2

London Financial News

BY DONALD J. FARQUHARSON
Special London Correspondent

LONDON, Nov. 27, 1928—There has been persistent buying of Northern Rhodesia copper shares, ostensibly on American account. Bwana M'Kubwa, Roan Antelope, N'Changa, and Rhodesia Congo Border Concessions have all participated and are higher. The current rumor that the first three named were to amalgamate has been promptly denied by the N'Changa company, but talk persists in the market that some such arrangement is imminent in relation to these concerns.

The "bulls" are having it all their own way in the tin market, but, although the price advances and the three months backwardation have been reduced, the stock position is not improved, and tin shares are not responding fully to the rising metal price. I hear from a usually well-informed source that the Anglo-Oriental group is not alone in the "bull" camp, having been joined by the Guggenheim interests, and that this combined force is confident of acquiring early control of two leading smelting companies, which, together with the Penpoll, would give it a "say" in the future of the metal. Further consolidation of Malayan producers is aimed at under the Anglo-Oriental group, so that curtailment of output, in the East as well as in Nigeria, may become effective.

I learn that negotiations are proceeding with an important overseas firm for the financing of further development and equipment of the Messina (Transvaal) Development Company's copper mine, which will include the addition of another rod mill to the three mills already in commission, thereby increasing the monthly milling capacity to over 25,000 tons. For the year to June 30 last, the profit was some £30,000 higher, at £116,250, and the dividend 5 per cent up at 32½ per cent. The mill treated 229,232 tons (a record), the average grade of ore being 3.05 per cent copper and the production 6,665 tons of copper. Reserves are 742,173 tons, averaging 3.11 per cent copper. No mention is made in the report concerning the discovery of asbestos on the property, which was the subject of recent rumor.

Doubts which exist concerning the position of the high-cost diamond producers have not been allayed by the De Beers Consolidated Mines' report. This reveals that, owing to overproduction of alluvial stones and consequent congestion of the market, sales of diamonds were on a considerably reduced scale. The dividend of 15s. per share compares with 30s. before, and this time £450,000 has been appropriated from dividend reserve. Nor are there many who take comfort from A. Chester Beatty's statement made at the Consolidated African Selection Trust's meeting, to the effect that "at the present time the demand for diamonds is excellent, and with the spirit of close co-operation now existing between producing companies, and with the increasing prosperity throughout the world, particularly in the United States, I think we may look forward with confidence to the future of the diamond industry."

According to African advices, the South African government has obtained from its alluvial diggings in Namaqualand diamonds to the value of £6,000,000 for an expenditure of £40,000. If these figures are near the truth, it means that working costs are well under 1s. per carat. Greatest importance attaches, therefore, not only to what must be the unrevealed discomfiture of the high-cost producers, but also to the recently reported discovery of the northerly extension of the Namaqualand alluvials into Southwest Africa—that is, to the north bank of the Orange River, part of the Consolidated Diamonds of South-West Africa's concession. Working costs for 1927 were 35s. per carat, and the selling price was £3 per carat. It is not hard to conjecture future profit to this company with costs reduced to a level such as is reported to obtain on the government's Namaqualand fields.

Chilean Nitrate Output Rises

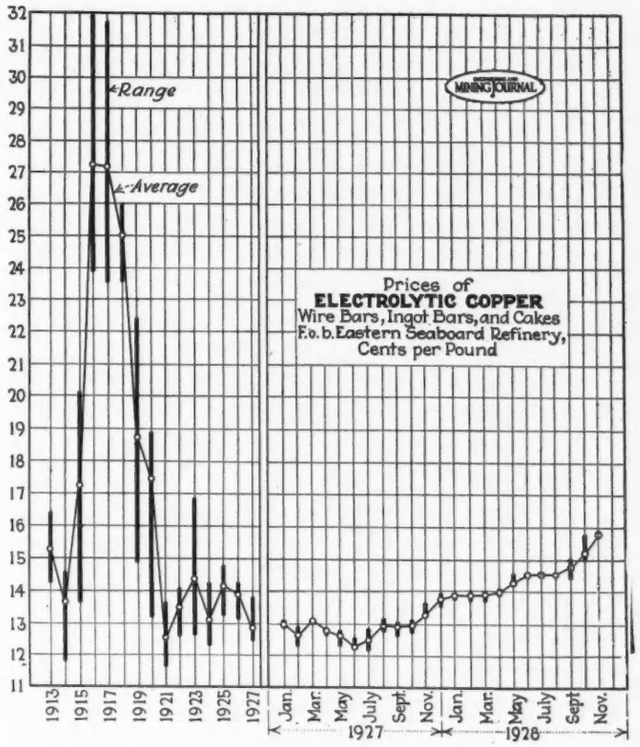
The 69 oficinas operating in Chile in September produced 259,400 metric tons of nitrate, compared with 143,800 metric tons during the same month last year, according to the U. S. Department of Commerce. Nitrate exports for September were 171,800 metric tons, in comparison with 205,500 metric tons in 1927. World stocks at the end of September, 1928, and September, 1927, were given as being 1,643,700 metric tons and 1,284,700 metric tons, respectively. It is reported that sales in the United States have declined, but that sales in Europe are considered satisfactory.

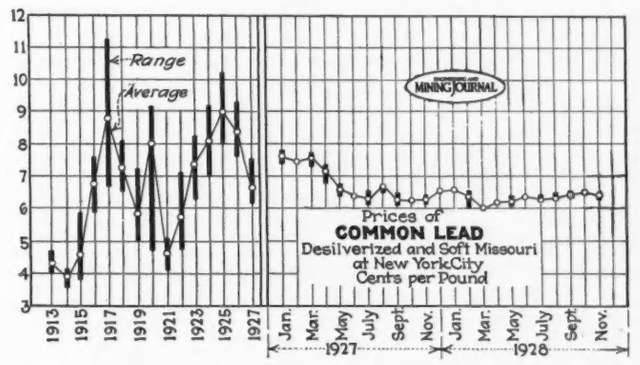
BROKEN HILL SOUTH, LTD., reports net operating income of £183,334 during the fiscal year ended June 30, 1928. Comparative costs and production data during the last two fiscal years are compared in the accompanying table:

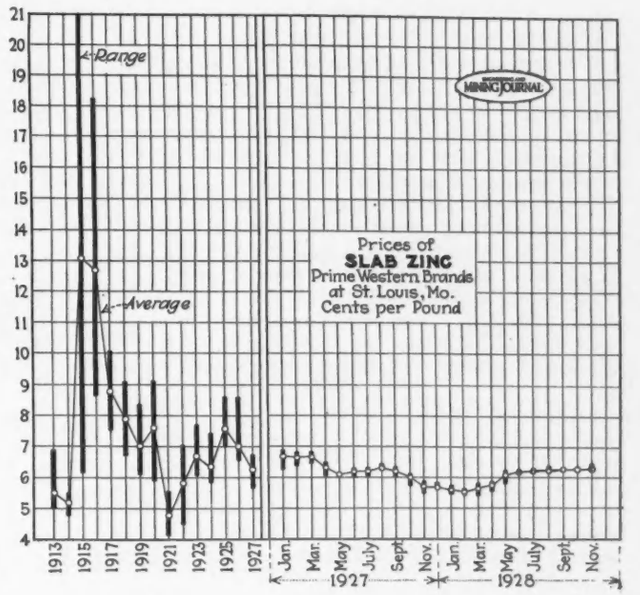
	Year Ended June 30, 1927	Year Ended June 30, 1928
Ore produced, tons	311,673	335,566
Ore produced, weekly, tons	5,994	6,453
	s. d.	s. d.
Ore extraction	26 1.0	24 10.2
Development	2 11.6	2 3.8
Ore treatment—lead	7 3.1	6 2.1
Ore treatment—zinc	4 6.9	4 8.4
Total cost per ton ore	40 10.6	38 0.5

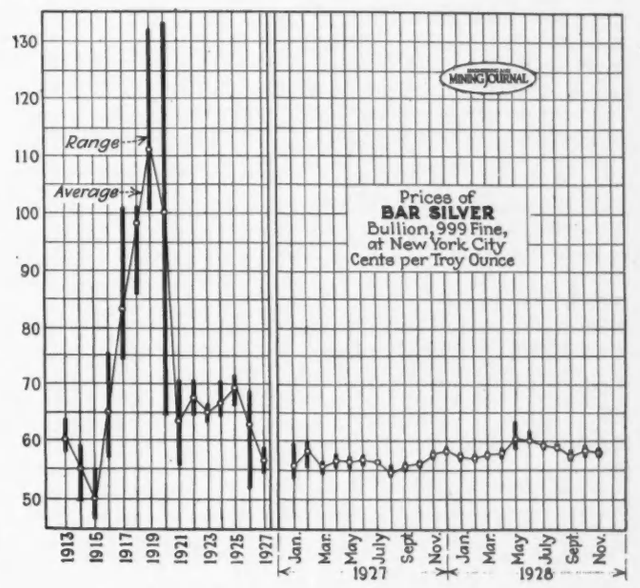
The Broken Hill South report is a comprehensive treatise, including metallurgical and cost data in great detail, and a most commendable variation from the customary English company report in this regard.

Metal Price Curves

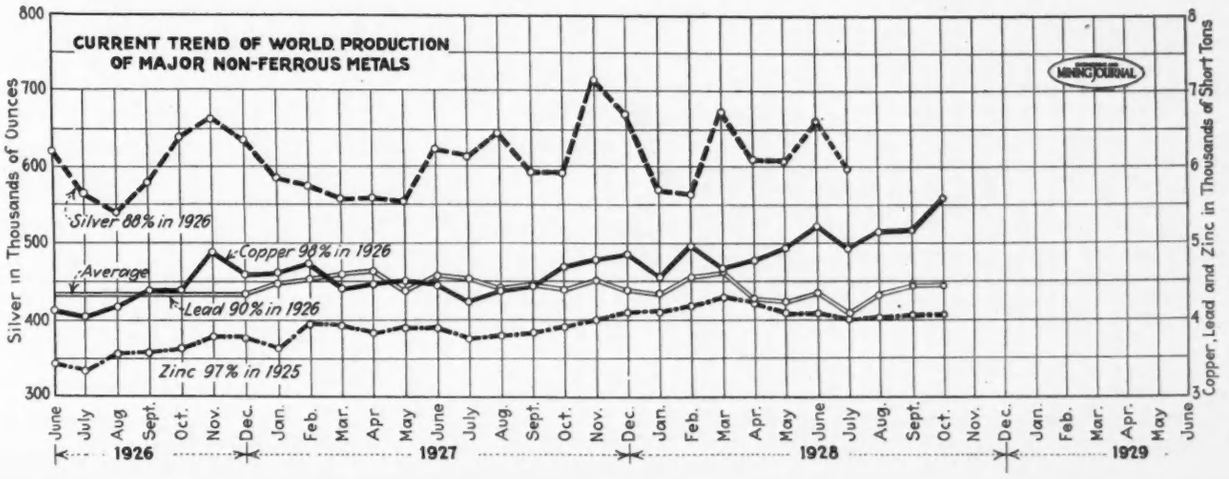








THE CURVES below are not to be considered as permanent records of production. They show merely the current trend in terms of daily output according to the latest estimates of the American Bureau of Metal Statistics. The figures represent production from countries that produce approximately 98 per cent of the world's copper, 97 per cent of the zinc, 90 per cent of the lead, and 88 per cent of the silver. The figures for lead on the new basis are not available for the individual months of 1926, and accordingly the horizontal line showing the monthly average reduced to a daily rate is shown. Delay in receipt of statistics from Mexico accounts for the failure of the silver curve to be up to date.



Review of Current Statistics

By Homar L. Johnson
Assistant Editor

THE release of October copper statistics by the American Bureau of Metal Statistics, early in November, was an event worthy of consideration in any statistical review of that period. Comparative data are shown in detail in the table at the bottom of this page. The extent of the increased consumptive demand, and of the present high rate of production, were features, and noteworthy, also, was the further decline in stocks of refined copper below the level that was supposed to represent the "danger line" or the "irreducible minimum" that prevailed some months ago.

Statisticians have pointed out that during periods of active demand and ascending prices, such as existed in October, ultimate consumers tend to buy further in advance of their requirements than is customary. This conclusion suggests that October shipments were somewhat in excess of actual consumption, and that neither November nor December shipments will attain the level recorded that month. Even so, however, there is no gainsaying the fact that the copper industry is in a remarkably prosperous condition, and likely to continue so for some time.

Engineering and Mining Journal's Weighted Index of Non-Ferrous Metal Prices continued on its way upward in November, a movement that has been sustained through four consecutive months. Copper, of course, has been largely responsible for this improvement. In November, the New York price of electrolytic copper was 0.576c. per pound higher than in October, and 2.459c. per pound above the November, 1927, figure. When consideration is given to the fact that an advance of 1c. per pound in the price of copper results in an advance of approximately 3 points in the Weighted Index Number, the explanation of the November Index's 1½-point advance over that for October, and its 7½-point advance over the November, 1927, figure, is revealed. Other monthly metal price movements were declines in silver and lead, that slightly exceeded, from a weighted standpoint, the advances registered by tin and zinc. The stable "mates," nickel and aluminum, continued in the even tenor of their respectively stabilized prices.

Consideration of metal-mining company share quotations naturally follows that of metal prices—though there have been times in recent months when that order appeared to have been reversed. The favorable condition of the copper industry and its improved future outlook, the general bull movement on the stock exchanges, augmented by the favorable Presidential election results—these factors and others of a similar nature contributed in sending copper-mining company shares, and those of the smelting-manufacturing group, to new high levels. Incidentally, the phrase "to new high levels" has been badly overworked of late, though the break in stock exchange prices that has taken place since the first of December will serve to allay that condition, temporarily, at least.

Among the seven mining-smelting-manufacturing companies a unanimous report of share appreciations is recorded. Anaconda was the leader in the November movement, having a slight edge on International Nickel in that respect. Nevertheless, Nickel continues to lead in total stock-market valuation, with a margin of nearly $24,000,000 at the end of November, as compared with approximately $27,000,000 at the end of October and a margin of nearly $40,000,000 in Anaconda's favor on Oct. 1. The anxiety of British interests to maintain their control of the proposed Mond-International merger is reported to have been a major factor in forcing the share quotations of International Nickel to the astounding heights recorded last month. To emphasize the extent of the appreciations in share prices in the last two years, the accompanying table compares share quotations at the end of January, 1927, with those at the end of November, 1928:

Smelting Group	Jan. '27	Nov. '28
Anaconda	$47.38	$111.13
Internat'l Nickel	40.00	214.00
New Jersey Zinc	185.00	240.00
American Metal	42.00	58.88
American Smelting	137.25	278.88
U. S. Smelting	33.63	66.88

November was the second consecutive month in which not one of the companies making up the copper group showed a decline in share quotations. Kennecott, as usual, because of its huge capitalization, had a major rôle in the advance. Chile Copper, Nevada Con., New Cornelia, and Inspiration contributed largely, diminishing in importance in the order named.

A slight improvement in the markets for lead and zinc during November as well as the further improvement in copper—and more or less sympathy with the general bull movement—resulted in an advance in the Index Number of the thirteen miscellaneous mining companies to 184 for November, exceeding the October figure by about 12 points. Cerro de Pasco, St. Joe Lead, Federal M. & S., Howe Sound, and Hecla made substantial advances, which were offset in part by lower quotations for Hollinger, Lake Shore, and Premier Gold.

Features of the October lead and zinc metal statistics, released during November, were a further decline in the daily rate of domestic zinc production, resulting in the lowest rate during any month of the last year being reported for October; domestic zinc deliveries were up 6,000 tons from the September total; zinc stocks declined by nearly 2,000 tons; and lead stocks were lower by 2,639 tons at the end of October. World production rates of lead and zinc showed but little change, though October copper production established a new record, both for the total and the daily rate.

E.&M.J. Weighted Index of Non-Ferrous Metal Prices

100 Is Composite for 1922-3-4

1920	130.92
1921	80.80
1922	93.94
1923	103.43
1924	102.63
1925	111.74
1926	107.74
1927	97.54

	1926	1927	1928
April	105.93	98.63	97.14
May	105.43	96.41	99.05
June	106.68	95.55	100.16
July	109.08	95.42	99.69
August	110.22	97.25	99.85
September	109.27	96.01	100.53
October	106.20	95.36	102.34
November	104.21	96.22	103.83

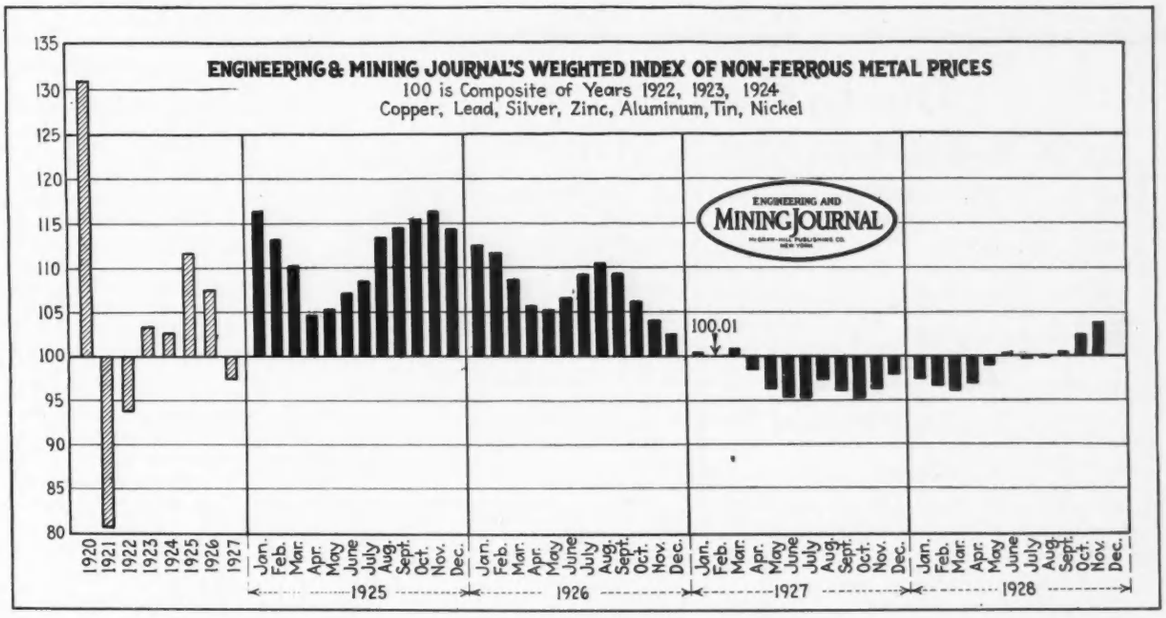
Current Statistics of Production and Stocks of Copper, Lead and Zinc

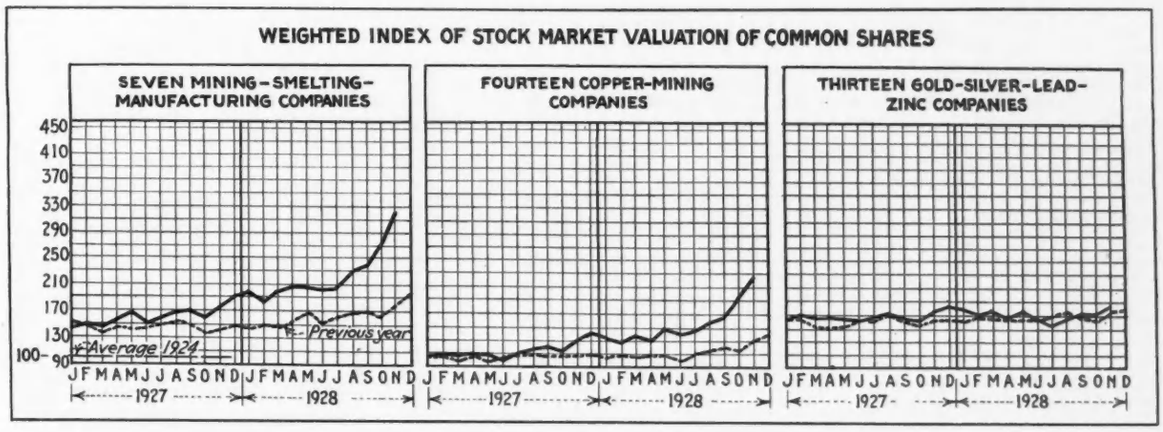
Data from American Bureau of Metal Statistics

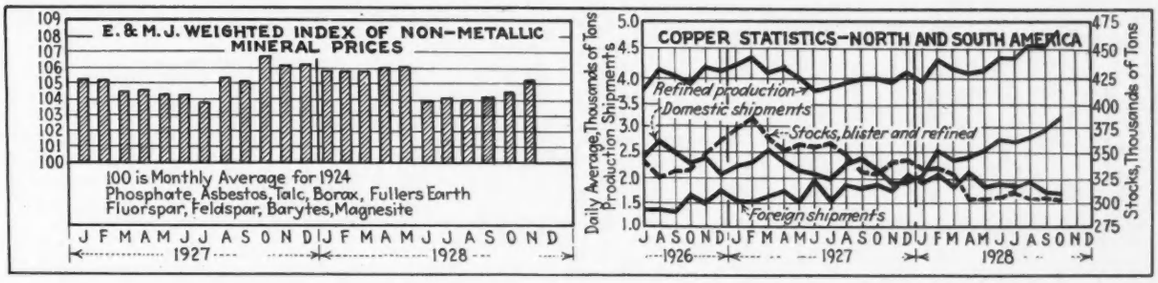
Figures Represent Short Tons

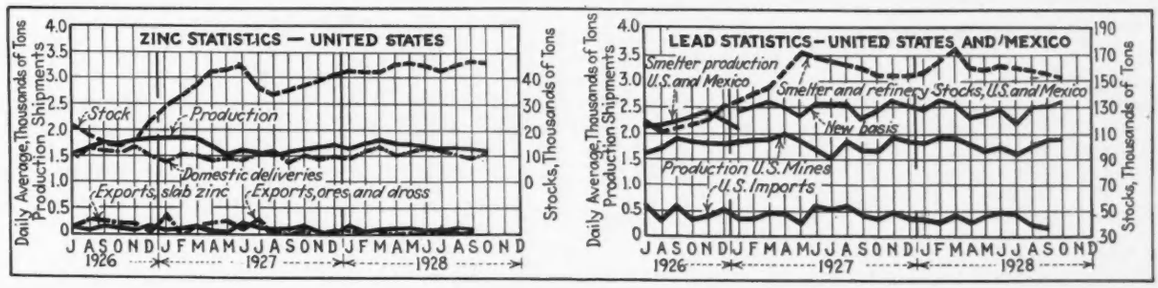
	1927		1928		
COPPER—North and South America	Average	October	August	September	October
Production, refined, daily average	4,045	4,030	4,631	4,567	4,813
Domestic shipments	68,737	68,619	83,398	88,707	100,371
Foreign shipments	53,489	58,919	60,240	51,292	54,992
Stocks, blister and refined	351,611	329,955	309,226	307,539	303,252
LEAD—United States and Mexico					
Production, smelter, daily average	2,513	2,448	2,499	2,503	2,599
Production, U. S. mines, daily average	1,798	1,710	1,780	1,839	1,879
Imports into U. S. A.	13,451	11,973	11,699	11,215	.....
Stocks, smelter and refinery	156,878	155,868	156,976	155,482	152,746
ZINC—United States					
Production, daily average	1,681	1,619	1,682	1,645	1,621
Domestic deliveries	45,811	46,602	47,050	44,103	50,126
Exports, slab zinc	3,468	4,940	2,923	127	.....
Exports, ores and dross	4,424	2,172	463	346	.....
Stocks	37,602	36,223	44,416	47,915	46,068
World Production Rate (Daily Average)					
Copper	4,543	4,685	5,124	5,151	5,601
Lead	4,514	4,449	4,350	4,484	4,487
Zinc	3,910	3,909	4,027	4,042	4,085

E. & M.J. Statistics of the Mining Industries









The Market Report

Quiet Prevails In Non-Ferrous Metal Markets

New York, Dec. 12, 1928—Buying of the non-ferrous metals during the last week has been the quietest in almost every instance that has been experienced in several months. Prices, in general, are quite firm, few indications of weakness having been observed. The total of copper sales is appreciably below the low mark reported last week. Lack of strength in the London lead market appears to have kept domestic consumers out of the domestic market during the early part of the last week, though the demand has improved considerably in the last few days—more or less coincident with signs of strength in London. Zinc buying activity has quieted down considerably from the extremely active business reported during preceding weeks. Tin has fluctuated over a relatively wide range. Antimony, platinum, and quicksilver are easier.

Daily Prices of Metals

Dec.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
6	15.775	50.625	6.50	6.325@6.35	6.35
7	15.775	49.75	6.50	6.325@6.35	6.35
8	15.775	49.00	6.50	6.325@6.35	6.35
10	15.775	50.125	6.50	6.325@6.35	6.35
11	15.775	49.50	6.50	6.30 @6.35	6.35
12	15.775	49.875	6.50	6.35	6.35
	15.775	49.813	6.500	6.338	6.350

Average prices for calendar week ending Dec. 8, 1928, are: Copper, 15.775; Straits tin, 51.104; N. Y. lead, 6.500; St. Louis lead, 6.340; zinc, 6.35; and silver, 57.458.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis: that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary form of wire bars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

Dec.	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic	Spot	3M	Spot	3M	Spot	3M
	Spot	3M							
6	68 3/16	68 9/16	74 3/4	231	229 7/8	21 5/16	21 11/16	26 1/8	26 1/2
7	68 1/4	68 1/2	74 3/4	227 1/4	225 3/8	21 1/8	21 9/16	26 7/16	26 13/16
10	68 1/16	68 3/8	74 3/4	225 1/2	223 1/2	21 1/4	21 11/16	26 1/2	26 3/4
11	68 1/8	68 7/16	74 3/4	227 1/2	225	21 1/8	21 5/8	26 5/8	26 3/4
12	68 5/16	68 9/16	74 3/4	225 1/4	222 3/8	21 5/16	21 11/16	26 3/4	26 3/4

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Dec.	Sterling Exchange "Checks"	Silver		Gold London	Dec.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
6	4.84 9/16	57 3/8	26 3/8	84s11 1/2d	10	4.84 5/8	56 7/8	26 1/4	84s11 1/2d
7	4.84 5/8	57 3/8	26 5/16	84s11 1/2d	11	4.84 5/8	57 1/4	26 5/16	84s11 1/2d
8	4.84 9/16	57 1/8	26 5/16	.....	12	4.84 5/8	57 1/4	26 5/16	84s11 1/2d
					Ave.		57.208		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

Extremely Quiet Week Is Reported in Copper

Sales of copper to domestic consumers during the last week have been in the smallest volume since the hot-weather buying lull of last July. Producers are not particularly concerned over this condition, except in so far as it indicates the storing up of consuming demand which may develop into a buying wave later on that will result in another price advance. The general feeling is that 16c. copper is a satisfactory price level and that any further advance is bound to be followed by a price reaction. Export business during the last week has been very quiet also, though somewhat better, proportionally, than that on domestic account. Copper Exporters, Inc., maintain their price at 16¼c. per pound, c.i.f. usual European destinations.

Statistics released today indicate that the high rate of shipments to domestic consumers in October was maintained in November, a condition which many authorities did not expect. The higher rate of production is beginning to be reflected in the statistics, as stocks of refinery and blister copper were higher by some 10,000 tons despite the continued high rate of shipments.

Lead Demand Slackens

The high level of lead sales that has been maintained for a number of weeks in the past was not reached during the week ending today. Continued weakness of spot lead in the London market has been a psychological factor in keeping consumers out of the market. On Dec. 7, the London price reached £21 1/8, approximately equivalent to the parity at which bullion or pig lead may profitably be imported into the United States under present domestic price conditions. The leading producers are in excellent statistical position, however, and it is not improbable that the major factors would feel inclined to maintain present prices and permit the importation of a certain amount of foreign lead to relieve pressure on the London market. London is somewhat stronger today, and domestic sales since the week end have shown considerable improvement. Corroding lead for first quarter, 1929, delivery has been in good demand. In the Middle West prices have ranged between 6.30 and 6.35c. per pound. Business in this market constituted the larger proportion of the week's total.

Zinc Market Quieter After a Month's Activitiy

The extremely active demand for zinc which prevailed throughout the greater part of November and during the first few days of December has abated. As

a result sales reported during the week ending today are again close to normal. Delivery as far ahead as May has been specified on several of the transactions, though the greater part of the tonnage has been for first-quarter and late December shipment.

Domestic zinc production in November totaled 50,260 tons, as compared with 50,259 tons in October, according to statistics released today by the A.B.M.S.

Tin Undergoes Wide Fluctuations

Occasioned largely by selling pressure in the Far East, and spasmodic support of the dominant bull group in London, the tin market has experienced extreme price variations during the last week. The net result has been a decline in price of close to 2c. per pound, indicating that the few periods during which the bull group gave support were of less importance than the combination of the selling pressure in Singapore and the periods during which they did not support the market. Consuming demand holds up remarkably well. Of particular interest to dealers and consumers of tin has been the news from Bolivia, where a boundary dispute with Parguay is in progress that may result in war. Outbreak of hostilities would undoubtedly affect tin production and would be a substantial aid to the advocates of the tin famine theory. Bolivia contributes about 30.000 tons annually, or about one-fifth of the entire world production.

Silver Steady and Lower

Reports from abroad indicated sales of silver for China account on several days during the past week. A moderate buying order from that quarter persisted in the local market, with no support from India. Prices eased off slightly, but the tone appears steady at the lower level.

Mexican Dollars (Old Mexican pesos): Dec. 6th and 7th, 43¼c.; 8th, 43c.; 10th, 42¾c.; 11th and 12th, 43⅛c.

Foreign Exchange

Closing cable quotations on Tuesday, Dec. 11, were: Francs, 3.90¾c.; marks, 23.83¾c.; and lire, 5.23⅞c. Canadian dollars, ¼ per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified

ALUMINUM—Per lb., 99 per cent plus grades, price of leading interest, 24.30c. Outside market, 99 per cent plus, 24.30c.: 98-99 per cent, 23.90c.

ANTIMONY—Per lb., duty paid, New York: Chinese brands, 9⅝c.@9¾c. per lb. for all positions. Cookson's "C" grade, spot, 15⅜c.

BISMUTH—Per lb., New York, in ton lots, $1.70. Smaller lots, $1.85 and up.

CADMIUM — Per lb., New York: 80@90c. Active demand.

IRIDIUM—Per oz., $275 for 98@99 per cent sponge and powder.

NICKEL—Per lb. ingot, 35c.; shot, 36c.; electrolytic, 37c. (99.9 per cent grade) for single lots of spot metal.

PALLADIUM — Per oz., $42@$46. Small lots bring up to $50. Nominal.

PLATINUM—Official price quoted by the leading interest on small miscellaneous orders for refined metal, per oz., $74 reduced from $76 per oz. on Dec. 8.

QUICKSILVER — Per 76-lb. flask, $122@$123, cash. Small lots command the usual premiums. Market is very quiet.

Prices of Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tantalum, Tellurium, Thallium, Tungsten, and Zirconium are unchanged from the issue of Dec. 8.

Metallic Ores

TUNGSTEN ORE—Per unit of WO_3, N. Y.: Wolframite, $11.50; Western scheelite, $11.50@$12.00. Nominal.

Chrome, Iron, Manganese, Tantalum, Titanium, and Vanadium ores are unchanged from quotations in the Dec. 8 issue.

Heavy Buying and Shipping of Zinc

Joplin, Mo., Dec. 8, 1928

Blende	Per Ton
High	$42.90
Premium blende, basis 60 per cent zinc	$40.00@ 41.00
Prime Western, basis 60 per cent zinc	39.00@ 40.00
Fines and slimes, 60 per cent zinc	36.00@ 38.00
Average settling price, all zinc	40.51
Galena	
High	$88.10
Basis 80 per cent lead (buyer's report)	85.00
Basis 80 per cent lead (seller's report)	87.50
Average settling price, all lead	85.13

Shipments for the week: Blende, 18,643; lead, 2,808 tons. Value, all ores the week, $994,360.

Shippers appear to have decided to replenish stocks at their plants before the severe cold freezes it solid in the open bins at the mines, and are loading out rapidly a large tonnage of the best ore in the bins. Stocks of the most desirable ore are tonight practically all sold, leaving an unsold balance of mixed, and therefore less desirable, ore in the bins. Fines and slimes were not successfully treated until sintering processes were introduced, which make it necessary that the ore be closely graded.

One bin of 1,510 tons of reserve lead was disposed of this week by the holder who asserts that a basis price of $87.50 was received in settlement. Buyers, however, declare that an $85 basis is the price for all other ores. The $85 basis is moving current production, but holders of reserve are expecting to receive a higher price

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Platteville, Wis., Dec. 8, 1928.

Zinc Blende	Per Ton
Blende, basis 60 per cent	$42.75
Lead Ore	
Lead, basis 80 per cent	$83.00

Shipments for the week: Blende, 875 tons; lead, none. Shipments for the year: Blende, 35,606 tons; lead, 1,770 tons. Shipments for the weak to separating plants, 1,390 tons blende.

Platteville, Wis., Dec. 1, 1928

Zinc Blende	Per Ton
Blende, basis 60 per cent	$42.75
Lead Ore	
Lead, basis 80 per cent	$83.00

Shipments for the week: Blende, 811 tons; lead, none. Shipments for the year: Blende, 34,731 tons; lead, 1,770 tons. Shipments for the week to separating plants, 1,291 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fuller's Earth, Garnet, Gilsonite, Graphite, Greensand, Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, and Tripoli are unchanged from prices in the Dec. 8 issue.

Metallic Compounds

ARSENIOUS OXIDE (White Arsenic) Per lb., 4c. Market firm.

COPPER SULPHATE (Blue Vitriol)—Per lb. in carload lots 5½c.

Antimony Oxide, Calcium Molybdate, Sodium Sulphate (Salt Cake), Sodium Nitrate, and Zinc Oxide are unchanged from prices in the Dec. 8 issue.

Alloys

FERROMANGANESE—Per long ton, domestic and foreign, f.o.b. furnace or duty paid, port of entry, $105. Spiegeleisen, 19@21 per cent, $33@$34 f.o.b. furnace.

Ferrocerium, Ferrochrome, Ferromolybdenum, Ferrophosphorus, Ferrosilicon, Ferrotitanium, Ferrotungsten, Ferrovanadium, Monel Metal, Nickel Silver and Yellow (Muntz) Metal are unchanged from prices in the Dec. 8 issue.

Rolled Metals

Copper, Lead and Zinc Sheets are unchanged from prices in the Dec. 8 issue.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and Zirkite are unchanged from quotations in the issue of Dec. 8.

Iron, Steel, and Coke

Iron—Per gross ton. Valley furnaces Bessemer, $18.25@$18.50; basic, $17.50@$18; No. 2 foundry, $18.

Steel—Base prices per gross ton. Pittsburgh, billets and slabs, $33@$34; plates, structural shapes, and soft steel bars, per lb., 1.90@2c.

Coke—Per gross ton, Connellsville furnace, $2.75. Connellsville foundry, $3.75@$4.85. By-product coke, Ohio and Kentucky, $7; Buffalo and Detroit, $8.50@$9.

Mining Stocks—Week Ended December 8, 1928

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	112⅛	95	95⅛	Oc.13, No. 19 Q	1.00
Andes Copper	New York	49½	38⅛	41⅛		
Ariz. Com'l	Boston	4⅞	4⅜	4⅜	Jl. 16, Jl. 31 SA	0.25
Cal. & Ariz	New York	122⅛	116½	107⅜	De. 1 De. 17 QX	2.50
Calumet & Hecla	Boston	44⅛	36	40	No 30, De.15,Q	1.00
Cerro de Pasco	New York	116⅛	96	97⅛	Oc.11, No. 1 Q	1.25
Chile Copper	New York	73	60⅜	62	De.5 , De.29 Q	0.75
Con. Coppermines	N. Y. Curb	15⅛	13	13		
Copper Range	Boston	28⅛	24	24	Mr. 24, Ap. 20 A	1.00
Crystal Copper	Boston Curb	*23	*20	*22		
East Butte	Boston	4⅛	3½	3⅜	Dec., 1919	0.50
Granby Consol	New York	83½	75	75½	Oc.11, No.1 Q	1.00
Greene Cananea	New York	158½	134½	135	De 1 , Ja.7 Q	1.50
Howe Sound	New York	70	61	61	Se.29, Oc.15, Q	1.00
Inspiration Consol	New York	45⅜	38½	38⅜	De. 20, Ja. 7 Q	0.75
Isle Royale	Boston	28	24	24	De.5, De.15 Q	0.50
Kennecott	New York	143½	128½	123⅜	No.30, Ja 2 Q	2.00
Magma Copper	New York	69¼	59½	59⅜	Oc.1, Oc.15 Q	0.75
Mason Valley	N. Y. Curb	2	1½	1¼		
Miami Copper	New York	30⅞	26⅛	26⅛	No.1, No.15, Q	0.37½
Mohawk	Boston	55	45½	46	Oc. 31, De. 1 Q	3.00
Montana-Idaho	Spokane	*10¼	*9½	*10½		
Mother Lode Coal	New York	4	3½	3¾	De.14, De. 31,	0.20
Nevada Consol	New York	38⅞	31	31	De.14, De.31 Q	0.50
New Cornelia	Boston	42⅛	36	36	No.2, No. 19 Q	0.50
Noranda	N. Y. Curb	64⅜	53½	53⅜		
North Butte	Boston	8	5½	6	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	2	1½	1⅜	Sept., 1926	0.03
Old Dominion	Boston	19⅜	16½	16½	Dec., 1918	1.00
Phelps Dodge	N. Y. Curb	195¼	185	190	De.18, Ja.2 Q	2.50
Quincy	Boston	44	37½	39	March, 1920	1.00
St. Mary's Min. Ld	Boston	37⅜	32	33⅜	No.20, De.1	1.00
Seneca Copper	New York	6	5	5		
Shattuck-Denn	N. Y. Curb	20½	17⅜	18		
Tenn. C. & C	New York	19½	16⅜	16⅜	Au., 31 Se.15,Q	0.25
United Verde Ex	N. Y. Curb	23	20½	21½	Oc.6, No.1 Q	0.50
Utah Copper	New York	260	250	250	De.14, Da.31 Q	3.00
Utah Metal & T	Boston	1⅜	1⅛	1¼	Dec., 1917	0.30
Walker Mining	Salt Lake	2.12½	2.05	2.05		
NICKEL-COPPER						
Internat. Nickel	New York	222½	200½	202	De.13, De.31 Q	0.75
Internat. Nickel pfd	New York	....	....	118½	Oc.1, No.1 Q	1.50
LEAD						
Gladstone Mtn	Spokane	*5½	*4⅜	*5	June, 1927	0.005
National Lead	New York	132	122	122	De.14, De.31 Q	1.25
National Lead, pfd. A	New York	140½	140	140	No.3, De.15 Q	1.75
National Lead, pfd. B	New York	118	118	118	Ja. 18, Fe 1 Q	1.50
St. Joseph Lead	New York	54⅛	47⅛	47⅛	Se.8, De.20 QX	0.75
ZINC						
Am. Z. L. & S	New York	44¾	26⅛	26⅛	May, 1917	1.00
Am. Z. L. & S. pfd	New York	101	97⅜	99	Nov., 1920	1.50
Butte C. & Z	New York	10⅞	8	8	De.14, De.31 Q	0.50
Butte & Superior	New York	11	10½	10⅜	Se.14, Se.29 Q	0.50
Callahan Zn-Ld	New York	3⅜	3⅛	3⅛	De., 1920	0.50
Consol.Lead&Zinc 'A'	St. Louis	12⅜	12	12	Je.25, Jl.1 Q	0.25
Eagle-Picher	Cincinnati	21⅜	19½	19½	No.15, De.1 Q	0.40
Eagle-Picher pfd	Cincinnati	110	110	110	July 15 Q	1.50
Evans-Wallower	N. Y. Curb	14⅜	11⅛	12½		
New Jersey Zn	N. Y. Curb	250	240	246	No. 20, De. 10 X	2.00
Treadwell-Yukon	Toronto	12½	11	11		
United Zinc	N. Y. Curb	1⅜	1⅜	1⅜		
Yellow Pine	Los Angeles	*23	*20	*20	Dec., 1925 QX	0.04
GOLD						
Alaska Juneau	New York	10⅜	7½	7½		
Barry-Hollinger	Toronto	*31½	*27½	*30		
Central Manitoba	Toronto	...	...	*78		
Coniaurium	Toronto	1.25	1.25	1.25		
Cresson Consol. G	N. Y. Curb	*83	*80	*82	Oct. 15, Q	0.02
Dome Mines	New York	9⅞	8½	9	Se.29, Oc.20 Q	0.25
Gold Hill	Toronto			*7½		
Golden Cycle	Colo.Springs	†1.54	†1.52	...	No. 30, De.10 Q	0.04
Hollinger Consol	Toronto	8.25	8.00	8.15	De 12, De. 31 M	0.05
Homestake Mining	New York	75½	75½	75½	De.20, De.26 M	0.50
Kirkland Lake	Toronto	1.46	1.30	1.35		
Lake Shore	Toronto	18	17	17.20	De.1, De.15 QX	0.40
McIntyre Porcupine	New York	21	20½	20½	No.1, De.1 Q	0.25
Portland	Colo.Springs	†*9½	†*7	....	Ap., 1927	0.02
Rand Mines	New York	...	...	36½	Au.21-28 Am.Sh	1.52
Sylvanite	Toronto	2.15	2.00	2.15		
Teck-Hughes	Toronto	8.60	8.30	8.35	Oc.17, No.1	0.15
Tom Reed	Los Angeles	*32½	*21	*21	Dec., 1926	0.02
Vipond Cons	Toronto	*62	*57	*61	April, 1927	0.03
Wright-Hargreaves	Toronto	2.03	1.54	1.67	Oc.16, No.1 Q	0 02½
GOLD AND SILVER						
Carnegie Metals	N. Y. Curb	22½	17⅛	19⅜		
Con. Cortez	N. Y. Curb			*15		
Dolores Esperanza	N. Y. Curb	1.00	*86	*86	July, 1923	0.05
N.Y. Hond's Rosario	N. Y. Curb	...	...	15⅜	Oc.17, Oc.27 QX	0.50
Premier Gold	N. Y. Curb	2¼	2 3/16	2 3/16	Se.14, Oc.4 Q	0.06
Tonopah Belmont	N. Y. Curb	*71	*61	*61	Oc., 1925	0.05
Tonopah Extension	N. Y. Curb	*10	*6	*6	Ap., 1925	0.05
Tonopah Mining	N. Y. Curb	3⅜	3¼	3 5/16	Se.29,Oc.20 SA	0.07½
West End Consol	N. Y. Curb	...	...	*3	Mar., 1923	0.05
Yukon Gold	Boston Curb	1	*77	*86	June, 1918	0.02
SILVER						
Castle-Trethewey	Toronto	*38	*36½	*36½		
Coniagas	Toronto	....	....	2.85	May, 1924	0.12
Keeley	Toronto	*40	*38	*40	Mr.1, Mr.15 SA	0.04
Mining Corp. Can	Toronto	4.15	3.50	3.65	De.6, De.20 SA	0.1½
Nipissing	N. Y. Curb	4¼	3	3⅜	Se.29, Oc.20 Q	0.07

Stock	Exch.	High	Low	Last		Last Div.
SILVER-LEAD						
Ahumada	New York	4⅛	3⅜	3⅜	Ap., 1927	0.12
Bingham Mines	Boston	47	46	46	Se.20, Oc. 5 MX	0.50
Bunker Hill & Sullivan	N. Y. Curb	131¼	128	128	Oc., 31,No. 5 X	0.75
Cardiff M. & M	Salt Lake	*35	*33	*33	Feb. 5, 1927	0.10
Chief Consol	Salt Lake	3.70	3.50	3.50	Ja.10, Fe.1 K	0.10
Consti'nMng.&Mill'g.	Spokane	*50	*40	*40		
Erupcion	Boston Curb	*25	*25	*25	Ja., 1928 Q	0.07½
Eureka Lily	Salt Lake	1.37½	1.32½	1.35		
Federal M. & S	New York	230	180	180	Je., 1927	10.00
Federal M. & S. pfd	New York	101¼	100	100	No. 23, De. 15 Q	1.75
Golconda	Spokane	*78	*75	*76		
Hecla Mining	N. Y. Curb	17	16½	16⅜	No.13, De.14 Q	0.15
Highland-Surprise	Spokane	*13½	*12	*12½		
Iron King Mining	Salt Lake	*90	*90	*90		
Keystone Mining	Salt Lake	†*35	†*25	...	Fe., 1926	0.07½
Lucky Jim	Spokane	*25	*24	*25		
Lucky Tiger-Com	Kansas City	†6.75	†6.50	...	No.4, No.20 M	0.05
Mammoth Mining	Salt Lake	*85	*75	*85	De., 1926	0.25
North Lily	Salt Lake	8.70	8.00	8.10	Oct., 20 I	0.20
Park Utah	New York	12⅛	10	10⅛	De.31, Ja.2 Q	0.20
Plutus Mining	Salt Lake	†2.00	†2.00	....	Ap.10, Ap.16 Q	0.10
Rico-Argentine	Salt Lake	*49	*48	*49	June 15 Q	0.03
Sherman Lead	Spokane	*25	*22	*23		
Silver King Coal	Salt Lake	13.50	13.25	13.25	Se.20, Oc.1 Q	0.25
Silversmith	Spokane	*8⅛	*6½	*8	Oct., 1926 Q	0.02
Strattons Mines	Spokane	1.73	1.50	1.70		
Sunshine M. Co	Spokane	1.43	1.37	1.43	June 20, K	0.02
Tamarack-Custer	Spokane	*40	*36½	*36½	Sept., 1924	0.25
Tintic Standard	Salt Lake	14.00	13.50	13.62½	Se.19, Se.29 QX	0.30
Utah-Apex	Boston	5	4⅛	4¼	Jl.14, Au.1 K	0.25
IRON						
Bethlehem Steel	New York	80½	72	74½	Jl., 1924	1.25
Cleveland-Cliffs Iron	Cleveland	142	119½	133½	Oc.15, Oc.25. Q	1.00
Colorado F & I, pfd	New York	75	63	64¾	Au.10, Au.25 Q	2.00
Gt. North'n Iron Ore	New York	31⅞	25⅛	25⅛	Ap. 9, Ap. 30 K	0.75
Inland Steel	New York	73½	69½	69½	No. 15, De.1 Q	0.62½
Republic I. & S	New York	84⅞	75⅜	76⅛	No. 14, De. 1 Q	1.00
Republic I. & S. pfd	New York	108⅜	108	108	De. 10, De. 20 Q	1.50
Sloss-Sheffield S. & I	New York	113	109	109	De.20, Ja.2 Q	1.75
Sloss-Shef. S.&I. pfd	New York	...	...	108	Se. 20, Oc. 1 Q	1.75
U. S. Steel	New York	166⅞	150½	151½	No.30, De.29 Q	1.75
U. S. Steel, pfd	New York	141¾	141¼	141½	No. 3, No.28 Q	1.75
Virginia I. C. & C	New York	...	...	25¼	Jan., 1924	1.50
Virginia I.C.&C. pfd	New York	52⅛	50⅛	50⅛	Je. 16, Jl. 2 SA	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol	New York	....	....	23	Ju.16, Ju.26 K	0.97
So. Am. G. & P	N. Y. Curb			3⅜		
Alum. Co. of Amer	N. Y. Curb	161½	140½	140½		
Alum. Co. of Amer. pf.	N. Y. Curb	107	106¾	107	Se. 15, Oc. 1 Q	1.75
Vanadium Corp	New York	102⅜	85	85	De.1,De. 15 QX	1.75
Patino M. & E	New York	37½	33⅛	33½	April, 1928	4s.
ASBESTOS						
Asbestos Corp	Montreal	19	18	18½	Jan., 1926	1.50
Asbestos Corp. pfd	Montreal	70	66	70	Se.29, Oc 15 Q	1.75
SULPHUR						
Freeport Texas	New York	47⅛	43⅜	43⅞	Oc.15, No.1 QX	1.25
Texas Gulf	New York	76	68⅜	69	De. 1, De 15 Q	1.00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	58½	51⅛	51⅜	No. 20, De 1 Q	0.75
Amer. Metal, pfd. 6%	New York	116½	115½	116	No.20, De.1 Q	1.50
Amer. Sm. & Ref	New York	282½	254⅛	255	Oc.11, No.1 Q	2.00
Amer. Sm. & Ref. pfd	New York	137½	137	137	No.2, De. 1 Q	1.75
Consol. M. & S	Montreal	370	364	370	Je.30, Jl.16 SA	6.25
Newmont Mining	N. Y. Curb	214½	185⅜	185⅜	Se.28, Oc.15 Q	1.00
U. S. Sm. R. & M	New York	67½	60⅛	61	Oc.5, Oc. 15 Q	0.87½
U.S. Sm. R.&M. pfd	New York	54½	54	54⅜	Oc. 5, Oc. 15 Q	0.87½

*Cents per share. †Bid or asked. Q, Quarterly. A, Annual. SA, Semi-annually. M, Monthly. FW, four weeks. K, irregular. I, Initial. X, Extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED November 27, 1928

Name	High	Low	Last	Date	Amount	Last Div.
Alaska Mexican ($5)	20/—	17/6	20/—			
Alaska Treadwell ($25)	100/—	100/—	100/—	Nov., 1926	4 (d)	
Aramayo Mines (25 frs.)	66/3	60/7	65/—	Nov., 1928	5 p.c. (†)	
Burma Corpn. (10 rupees)	15/9	14/10½	15/1½	Aug., 1928	6 annas*	
Bwana M'Kubwa (5s)	9/4½	8/4½	9/—			
Camp Bird (2s)	3/4½	3/1½	3/3	April, 1928	16⅔ p.c.	
El Oro (£1)	5/—	4/9	5/—	Nov., 1924	2½ p.c.*	
Frontino & Bolivia (£1)	9/6	8/9	8/9	July, 1928	3½ p.c.	
Mexican Corpn.(£1)	9/3	8/3	9/3			
Mexico Mines of El Oro (£1)	28/9	23/9	27/6	Dec., 1926	3½ p.c.*	
Mond Nickel	151/3	131/10½	151/3	Aug., 1928	20 p.c.	
Mount Isa (£1)	33/1½	31/10½	33/1½			
N'Changa Copper Mining	26/7½	20/—	25/3			
Oroville Dredging (4s)	4/9	4/3	4/6	Nov., 1927	31½ p.c.	
Rhodesian Congo Border (£1)	40/7½	33/1½	37/6			
St. John del Rey (£1)	12/3	11/6	12/3	Dec, 1928	2½ p.c.	
San Francisco Mines (10s)	29/3	28/—	29/3	July 1928	12½ p.c.	
Santa Gertrudis (£1)	14/6	14/—	14/3	July 1928	7½ p.c.	
Selukwe (2s. 6d.)	9/1½	7/3	8/3	April, 1917	6¾ p.c.	
S. Amer. Copper (2s.)	2/3	2/—	2/—	Nov., 1917	75 p.c.	
Tanganyika (£1)	63/1½	59/4½	60/—	July 1928	5 p.c.	
Union Miniere du Haut-Katanga (Brussels)	11,115	10,810	10,890	July, 1928	182.60 (b)	

*Free of British income tax. †Swiss francs and plus 15 p. c. bonus. ‡Belgian frs. and free of taxation.